AN EXPLORATION OF HYBRID ART AND DESIGN PRACTICE USING COMPUTER-BASED DESIGN AND FABRICATION TOOLS.

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Keywords
ART, DESIGN, DIGITAL, HYBRID, TECHNOLOGY, TRANSDISCIPLINARY

Abstract
The researcher's previous experience suggested the use of computer-based design and fabrication tools might enable new models of practice that yield a greater integration between the 3D art and design disciplines. A critical, contextual review was conducted to assess what kinds of objects are being produced by art and design practitioners; what the significant characteristics of these objects might be; and what technological, theoretical and contextual frameworks support their making. A survey of international practitioners was undertaken to establish how practitioners use these tools and engage with other art and design disciplines. From these a formalised system of analysis was developed to derive evaluative criteria for these objects.

The researcher developed a curatorial framework for a public exhibition and symposium that explored the direction that art and design practitioners are taking in relation to computer-based tools. These events allowed the researcher to survey existing works, explore future trends, gather audience and peer response and engage the broader community of interest around the field of enquiry. Interviews were conducted with practitioners whose work was included in this exhibition and project stakeholders to reveal patterns and themes relevant to the theoretical framework of this study.

A model of the phases that practitioners go through when they integrate computer-based tools into their practice was derived from an existing technology adoption model. Also, a contemporary version of R. Krauss's 'Klein Group' was developed that considers developments in the field from the use of digital technologies. This was used to model the context within which the researcher's practice is located. The research identifies a form of 'technology-led-practice' and an increased capacity for a 'transdisciplinary discourse' at the intersection of disciplinary domains. This study will be of interest to practitioners from across the 3D art and design disciplines that use computer-based tools.

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Ann Arbor, Michigan, 2008.

1.0 Introduction

This research is concerned with designed objects created from the application of computer-based production methods that might offer possibilities for new forms of cross-disciplinary or hybrid art and design practice. This thesis represents a snapshot of current practice in the field of enquiry. It provides the opportunity to critically reflect on this context (within which the researcher's practice is located) and to begin to define analytical terms to make distinctions between projects across disciplinary boundaries. The basic argument developed in this thesis is that an increasing number of practitioners are able and willing to negotiate working across previously designated disciplinary domains through the use of computer-based design and fabrication tools. These tools include: computer aided design (CAD), 3D object scanning, rapid prototyping (RP) and industrial rapid manufacturing (RM) and technologies such as computer numerically controlled (CNC) cutting and milling. The term 'computer-based tools' is being used by the researcher to point out an expanded field of use beyond the strictly commercial and industrial applications usually referred to as 'CAD/CAM' (computer aided design and manufacture). Other object-based or spatial technologies not yet associated with industrial manufacture are also indicated. These include: motion capture, the use of embedded sensors and actuators and Radio Frequency Identification (RFID) tags or transponders that turn physical objects into tangible or spatial interfaces.

1.1 Researcher's previous experience

The researcher's professional career has focused on collaborative practice since 1993. The researcher is a working artist, curator and designer with a background that encompasses industrial design and manufacture, architectural collaborations and fine art practice. The researcher co-founded the creative partnership 'rootoftwo'[1] in 1998 to explore technology as a driver of disciplinary convergence. 'rootoftwo' specialises in the design of experimental objects and spaces that challenge existing expectations and established behaviour by means of unconventional design methodologies. These projects explore the territory where objects are dynamic and responsive. Increasingly, these objects are designed and fabricated by computer-based tools.

[1] http://www.rootoftwo.com/

The researcher was first exposed to computer-based design and fabrication tools in 1997 at Manchester Metropolitan University. This was through (his then MA degree advisor) Keith Brown's involvement in the 'CALM' (Creating Art with Layer Manufacture) project 1997-98. This project was set up by the Higher Education Funding Councils as part of an initiative to promote the use of IT within the art and design community in UK higher education. The network of contacts between artists and engineers that was built up during this project resulted in the creation of the organisation Fast-uk[2] (Fine Art Sculptors and Technology in the UK – now, Fine Art, Science and Technology in the UK). The researcher was a founder member and is the organisation's Vice President.

Between 1999 and 2003 the researcher worked as part of a collaborative product development team for the Evenflo Company, Inc. (Vandalia, Ohio, USA). Throughout this time the researcher worked daily with engineers and designers making aesthetic and functional models, prototypes and sales samples. The researcher was instrumental in transitioning Evenflo's model shop from traditional hand-working methods to a computer-based rapid prototyping, silicone tooling and cast urethane reproduction process. Within the first annual product development cycle after implementing the use of this rapid prototyping technology Evenflo increased its number of new products from twelve to thirty-six a year. The researcher also took part in evaluating new product needs, working closely with marketing, engineering and tooling personnel throughout the product development process.

During this period the researcher co-founded 'artcore' - an unincorporated artist run non-profit organisation. In 2001, 'artcore' presented the rapid prototype art exhibition 'Intersculpt:Ohio 01'. Funding for this project was raised from various sources including public funds from the Ohio Arts Council and cash and in-kind donations from corporations, organisations and individuals. Subsequently, in 2003 the researcher returned to the UK and co-curated the exhibition 'Intersculpt:UK 03' for Fast-uk at the Museum of Science & Industry in Manchester. This exhibition was funded by The Arts Council of England, Manchester City Council and the Manchester Institute for Research & Innovation in Art & Design (MIRIAD).

[2] http://www.fastuk.org.uk/

Since 2002, the researcher has also been working with US-based public artist, Malcolm Cochran. The researcher's role was to create digital visualisations, renderings and construction drawings of Cochran's projects. These included: Hudson River Park, New York City; The Ohio Supreme Court Building and Goodale Park, Columbus, Ohio; and Changhua National University campus in Taiwan.

The researcher's practice is located across art and design disciplines in both industrial and cultural contexts. This practice was initially located within a fine art (sculpture) context but has expanded to involve the use of computer-based technologies in consumer product development, artist-architect collaborations and curating exhibitions featuring practitioners that make use of computer-based tools. The current research proposition is informed by this cross-disciplinary experience.

1.2 Rationale for the research

The rationale for this study has emerged from the researcher's professional practice. This practice has involved the use of various computer-based tools within several contexts. This previous experience suggested the current research proposition that the use of these technologies might enable new models of practice that yield a greater integration between the 3D art and design disciplines. The aim of this study is to establish a clearer understanding of the use of computer-based tools in object-making within art and design practice. The focus of the research is to explore and evaluate work happening across traditional disciplines through the use of common digital technologies. The researcher expects that this will help to find out if the work being produced in this manner suggests a trend towards a new hybrid model of 3D art and design practice.

This research is important now because the art and design disciplines are experiencing discontinuities with previous models of academic and professional practice arising out of increasing globalisation and the spread of new information-based economic paradigms. Computer-based tools are implicated as both cause of and potential solution to these issues. These changes are themselves responses to greater changes taking place on a worldwide scale. The

transition to an information-based economy offers opportunities for art and design practitioners to develop new production paradigms, design vocabularies and methodologies. However, research and teaching in universities will also need to embrace this development to stay competitive. The Cox Review of Creativity in Business (Cox, 2005, p.33) recommends that multidisciplinary postgraduate programmes in creativity, technology and business be created within certain universities as centres of excellence. In his 2006 RSA lecture Stephen Heppell (Heppell, 2006) indicates that education needs to be 'project-based' rather than 'discipline-based'. However, since universities are structured around disciplines - there are obvious disadvantages for cross-disciplinary research and teaching (Russell, 2000). For these types of programmes to survive within the disciplinary structure of the university support for boundary-crossing research such as the current study will have to increase.

Since the mid 1990s computer-based technologies have become increasingly affordable to and usable by a mass population (in the industrialised world). This has resulted in a democratisation of digital technologies. This has come with similar effects on the manufacturing processes more commonly associated with industrial production (Von Hippel, 2005, p.13). In recent years the use of digital technologies in art and design disciplines has also increased dramatically. Until now the discourse surrounding this development has mostly focused on the benefits this has brought for productivity. This has only recently touched on the possibilities that visual computing brings to the way in which we work (for example Callicott, 2001; Lynn & Rashid, 2002; Atkinson, 2003; Hensel, Menges & Weinstock, 2004; and Gershenfeld, 2005). Artists, designers, engineers, architects and craftspeople are now using a common digital toolset (Callicott, 2001, p.64). As production methods become more accessible, new creative possibilities arise that would not have been possible formerly. The present study provides an opportunity to explore and evaluate what new types of computer-aided designed and manufactured objects are being created by art and design practitioners.

The specific research questions to be addressed:

- Are there new kinds of objects being produced by art and design practitioners using computer-based tools?
- What are the significant characteristics of these objects and are there specific criteria which can be used to identify these new kinds of objects?
- Is there a trend towards a hybrid model of art and design practice emerging out of the use of computer-based tools and if so, what implications might this have for future practice?

This research will make a significant contribution to new knowledge through developing analytical and evaluative criteria, models and critical language for computer-designed and/or fabricated objects. Further contributions will be made by mapping the current use of computer-based technologies in art and design through case studies, surveys and interviews of contemporary practitioners. The research will explore new methods of working and new production ontologies and cultural contexts for computer-designed and/or fabricated objects by evaluating a body of work that exploits computer-based technologies. The research aims to benefit both the wider community of art and design practitioners using computer-based tools and the professional practice of the researcher.

2.0 Critical and contextual review

This review was conducted to provide a theoretical platform on which to build the main argument of the study. The contextual review is structured to clarify the current use of computer-based tools in object-making across art and design disciplines. Furthermore, the focus of the review is to locate and critically assess information about objects produced through the use of computer-based tools. The purpose is to find out what kinds of objects are being produced by art and design practitioners; what the significant characteristics of these objects might be; and what technological, theoretical and contextual frameworks support their making.

The researcher conducted a review of a broad range of text-based and visual reference material: books, journals, catalogues, conference papers, exhibitions, websites, etc. The researcher felt it was necessary to carry out this wide-ranging literature review to provide a critical framework that would cover the use of computer-based technologies from multiple disciplinary perspectives and within different contexts. Besides this, a review of literature about the impact of new technologies from widespread sources was completed. For example, how economics, education, computer science, new media, HCI and sociology have responded was looked into to provide examples and models that could be applied or adapted to the field of enquiry.

2.1 Technological context

Computer-based tools have been adopted by diverse practitioners from across the 3D art and design making disciplines. This adoption has been concerned with applying digital technology to conventional industrial techniques and processes (for example McDonald, Ryall and Wimpenny, 2001; Hopkinson, Hague and Dickens, 2005). This thesis explores the use of design computing that might afford the possibility to rethink the nature of a practice driven by these technologies.

The growth in ownership of powerful, cheap, personal computers and the parallel upsurge in use of and access to the Internet has transformed the means by which we communicate, carry-out work and entertain ourselves. This has also brought about improved functionality for traditional design techniques,

helping practitioners from many areas to bring their ideas to fruition with increased speed and productivity. Over the past decade we have witnessed an unprecedented development and increased accessibility of CAD/CAM (Computer Aided Design/Manufacture) technologies.

In 'Computer Aided Manufacture in Architecture' Nick Callicott covers both the origins of CAD/CAM and explores - by case studies of his own projects with sixteen*(makers)[3] - the potential for future applications outside conventional manufacturing (Callicott, 2001). Callicott shows that industrial manufacturing has historically compelled a separation of design and production which resulted in producing large numbers of standardised products displaying minimum variation. More recently, digital technologies have afforded alternatives to this model. Techniques explored by Callicott include both the rapid prototyping of contemplative, functional and interactive objects within the design studio; and large-scale examples within manufacturing industry using Computer Numerical Controlled (CNC) machining. By placing CAM within the context of both traditional craft and mechanised mass production, this book seeks a revision of the understanding of production and how the manufacturing process can be transformed into a 'making' process. Callicott argues that full exploitation of these technologies takes awareness of their relationship with existing practices of designing and making.

Art and design practitioners that have adopted 3D modelling software, CNC machines and rapid prototyping and manufacturing (RP&M) technologies have unprecedented opportunities. They can design objects and structures that can be realised by new materials and building techniques which circumvent traditional haptic, craft-based skill sets. The spread of these technologies has brought about the opportunity for practitioners with no background in engineering to make use of these them. The practical aspect of increased speed and productivity in the use of these technologies is important to all users. However, the conceptual realisations and the possibility of making innovative types of object for new forms of audience or market (Attfield, 2000, p.62) are of equal importance but are perhaps less immediately obvious. These tools confront practitioners with decreased concerns of 'how' to make something. At

[3] http://www.sixteenmakers.com/

the same time they offer a greater opportunity to engage with 'what' an object is (Dunne, 1999, p.12). For example, with RP there is no need to worry about undercuts[4] since there is no mould involved.

The expanded access to these technologies has come about by software applications that compile the necessary programming code from a virtual representation of the designed object. This capacity has essentially made programming the necessary instructions to fabricate a complex geometric entity into a visual activity (Callicott, 2001, p.55). Through adopting these technologies, the processes of design and production have been brought closer together. Designs that were previously too expensive or too experimental to be realised are now more practical propositions (Callicott, 2001, p.5) within the reach of less-specialised practitioners working alone or in smaller groups. These technologies already support small-scale manufacturing and customised manufacture and production[5]. This type of object accounts for a minor share of the overall market with the technologies mostly being used for making commercially designed prototypes. However, now the Internet is starting to create a demand for RP to small-scale production. The tools to support 'on-demand' production/fabrication are becoming more accessible to small enterprises.

2.2 A brief history of art and (industrial) technology

One of the key drivers for this research is to identify the mechanisms for integration of formerly industrial technologies into art and design practice. The relationship between art and technology is an interesting one. It could be claimed that in our contemporary digital age 'art' and 'technology' are in convergence. This is referred to as a 'third culture' by Brockman (1995) drawing on ideas developed by Snow (1959) in an analysis of the cultures of the arts and humanities; and science and technology. This idea of a hybrid 'third culture' is an important one for this study. The current research seeks to re-examine object making using computer-based design and fabrication tools from a

[4] RP does present its own concerns such as the orientation of the part and the generation of support structures to optimise the build and of course if the part produced has to be moulded then parting lines and undercuts are just as important.

[5] This is easily illustrated by the computer-manufactured designs for lighting and decorative objects rapid manufactured and sold under the .MGX brand by the company Materialise (specialists in the field of RP). http://www.materialise-mgx.com/

synthetic or pluralist perspective to propose evaluative criteria for a cross-disciplinary or 'third culture' approach to this activity. Before we can do this we should establish the forerunners of the present enquiry as a way of exploring this approach.

The overlap between art, design and technology is nothing new. Etymologically, the root of the word 'design' is connected to 'art' and 'technology' (Flusser, 1999, p.18-19). Historically, art and technology have been increasingly culturally segregated with design forming a bridge between the two:

> "Modern bourgeois culture made a sharp division between the world of the arts and that of technology and machines; hence culture was split into two mutually exclusive branches: one scientific, quantifiable and 'hard' the other aesthetic, evaluative and 'soft'. This unfortunate split started to become irreversible towards the end of the nineteenth century. In the gap, the word design formed a bridge between the two. It could do this since it is an expression of the internal connection between art and technology. Hence in contemporary life, design more or less indicates the site where art and technology (along with their respective evaluative and scientific ways of thinking) come together as equals, making a new form of culture possible." (Flusser, 1999, p.18-19)

The Greek word *techne* is related to *tekton* (a carpenter). There is an interesting discussion of *techne* in Heidegger (1977, p.12-35). Here Heidegger harkens back to ancient Greece where *techne* is part of *poeisis* (fine arts) and is a type of knowing. Heidegger imagines a classical Greek culture in which art is not a separate function within society but performs an integrative function bringing together religious, political, and social life. In this sense Heidegger's *techne* encompasses both manufacturing and the arts.

> "The quasi-technological concept of the artist, far from being just an ultra- or post-modern phenomenon, brings the story of the aesthetic full circle, back to the ancient Greek idea of art as a form of 'techne'...we are then faced, perhaps not with a banal opposition of art and technology (since at their origin art and technology are fundamentally the same), but with the need to make distinctions between different possibilities inherent in the history of 'technology'." (Newman, 1994, p. 78).

From the time of the Renaissance onwards creative practitioners have worked across the areas that have come to be thought of as the fine and applied arts. This was brought to the forefront in the technological levelling-out of

traditional, disciplinary distinctions that was a critical driver of De Stijl in The Netherlands, the Bauhaus in Germany and the Russian Constructivists in the early 20th Century. The architects, artists and designers working in these (historical avant-garde[6]) movements saw industrial modes of production as supporting mass availability and a unified machine aesthetic and a means of moving art into life:

> "...many artists championed the industrial artifact - generated mechanically and consumed collectively - over the singular work of aesthetic contemplation" (Lupton, 1998, p.50-81)

> "The ultimate, if distant, goal of the Bauhaus is the collective work of art - the Building - in which no barriers exist between the structural and the decorative arts." (Gropius, 1923, p.311)

The late 20th Century has seen computing technologies become increasingly affordable and prevalent. This has resulted in a democratisation of computer-based design and fabrication tools and the production processes more commonly associated with industrial patronage (Von Hippel, 2005, p.122-123). Christiane Paul has indicated the increasing ubiquity of digital technologies in the 1990s and onwards (Paul, 2003, p.7). Paul makes the distinction throughout her study of separating projects into the use of digital technologies as a tool or as a medium. This current research concentrates on those computer-based industrial technologies necessary for the production of physical objects rather than computer-based communication technologies. In their critical introduction to new media Lister, Dovey, Giddings, Grant and Kelly (2003, p.52) present a simple model of the complex of histories 'through' and 'against' which new media emerge.

[6] Peter Bürger in Theory of the avant-garde, translation by Michael Shaw, Minneapolis, University of Minnesota Press, 1984.

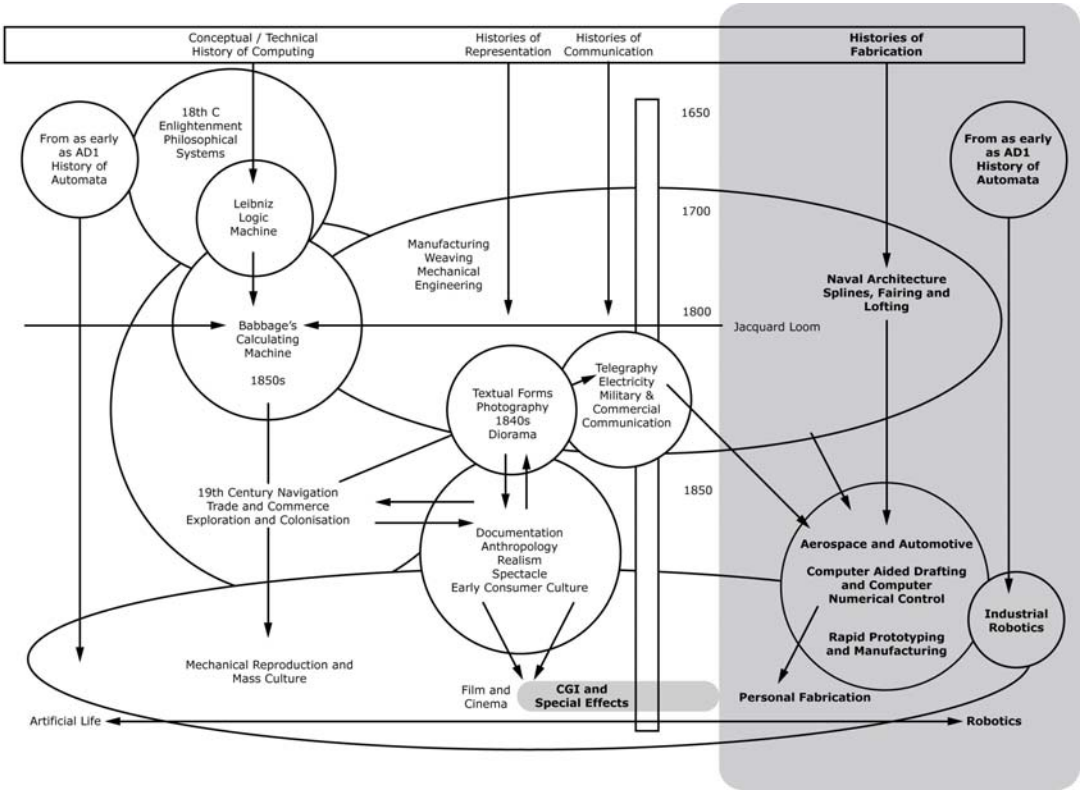

Figure 1: A simple model of the complex of histories 'through' and 'against' which objects in the field of enquiry emerge (after Lister, Dovey, Giddings, Grant and Kelly (2003) with the new contribution marked in gray)

This includes the conceptual and technical history of computing, histories of representation and histories of communication. These are parallel developments that inform and sometimes overlap this study. However, this study is more accurately framed in the context of histories of fabrication. In (Figure 1) the researcher has indicated a possible parallel course for this and how it might relate to the overall schema of Lister, Dovey, Giddings, Grant and Kelly's model. The current study is located in the space between developments arising out of manufacturing, weaving and mechanical engineering; and CGI and special effects. It is oriented towards developments in artificial life and robotics - where physical objects assume autonomy from the people that designed and made them.

2.2.1 Early developments

In 'A History of Curves and Surfaces in CAGD' (Computer Aided Geometric Design) (Farin, 2002) the earliest use of stored construction geometry in a manufacturing environment is dated to Roman times. This was in the form of reusable templates in shipbuilding. In this way a vessel's basic geometry did not

have to be recreated from scratch each time. Farin points out these techniques were perfected by the Venetians from the 13th to the 16th Centuries. Farin also notes the earliest mention of a 'spline' in relation to draft practices for building vessels from 1752[7]. This shows the relationship between the development of computer-based design and fabrication tools and the act of making. A 'spline' was a long strip of wood held in place with lead weights that would form the smoothest possible shape through those points allowing curved lines to be drawn (Figure 2).

Figure 2: 'Splines' are long, flexible battens used in conjunction with spline weights to draw fair curves while drawing a boat's lines and during the lofting process

In the 1940s, mathematicians developed formulae to describe this type of curve. These are still known as 'splines' (Figure 3). At the same time Roy Liming (1944) combined drafting methods and analogue computation in the production of fighter planes for the first time. Subsequently, John T. Parsons devised a method that would use IBM punch card accounting machines to control a milling machine to make wing panels for a Lockheed bomber. In the 1950s Paul de Casteljau at Citroën and Pierre Bézier at Renault developed methods of generating mathematically precise representations of freeform surfaces for car bodies that could be reproduced whenever necessary (Farin, 2002, p.4). At MIT the Automated Programming Tools (APT) programming language was developed to store numerical instructions used to control milling machines for producing dies and stamps for sheet metal parts. Patrick Hanratty (American Machinist, 1998) also developed the first commercial numerical control programming language while working at General Electric before moving to

[7] Duhamel du Monceau, H.L., 1752. Elements de l'architecture navale ou traite pratique de la construction des vaissaux. Paris.

General Motors to begin developing its first CAD/CAM system DAC-1 (Design Augmented by Computer).

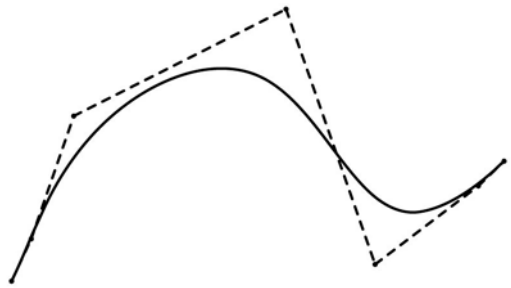

Figure 3: 'NURBS' (non-uniform, rational Bézier-splines) are mathematical models commonly used in computer graphics for generating and representing curves and surfaces

2.2.2 1960s

In 1960 William Fetter at Boeing coined the term 'computer graphics' for his human factors cockpit drawings. The first interactive graphics system ('Sketchpad: A Man-Machine Graphical Communication System') was invented by Ian Sutherland at MIT 1961-63 (Time-Life Books, 1986). Already in the early 1960s with computing and digital manufacturing in their infancy these technologies were co-opted for creative purposes. The first two exhibitions of computer art (at the Wise Gallery in New York and at Hochschule für Technik in Stuttgart, Germany, both in 1965) were organised by scientists (Carlson, undated). The following year Experiments in Art and Technology (E.A.T.) was founded by engineers Billy Klüver and Fred Waldhauer and artists Robert Rauschenberg and Robert Whitman in New York (Klüver, 2000). The same year the Center for Advanced Visual Studies was founded by Gyorgy Kepes at MIT (Center for Advanced Visual Studies, 2007).

In 1968 Charles Csuri created the sculpture 'Ridges Over Time' on a three-axis, continuous path, numerically controlled milling machine (ACM Siggraph, 1996). The instructions for this were generated from punched tape. Also in 1968 came one of the most referenced exhibitions in the history of art and computing. 'Cybernetic Serendipity: The Computer and the Arts' was curated by Jasia Reichardt at the Institute of Contemporary Arts, London (Reichardt, 2005). However, within the scope of this study another exhibition of that year should

also be recognised as a key event. 'The Machine as Seen at the End of the Mechanical Age' was curated by K. G. Pontus Hultén at The Museum of Modern Art (MOMA), New York (Pontus Hultén, 1968). E.A.T. arranged a competition in connection with this exhibition for which around two hundred works were submitted from nine countries. The selection was based on the inventive and imaginative use of technology and the extent to which engineers and the artists had collaborated successfully. That same year Swainson proposed a process to directly fabricate a plastic pattern by selective three-dimensional polymerisation of a photosensitive polymer at the intersection of two laser beams (Beaman, 1997). This is an early forerunner of rapid prototyping (SLA®). Also in 1968 The Computer Arts Society (CAS) was founded (Computer Arts Society, 2007). They held their first exhibition 'Event One' at the Royal College of Art, London in 1969.

2.2.3 1970s

In the 1970's CAM systems such as Bézier's UNISURF and Hanratty's ADAM (Automated Drafting and Machining) were created. Jack Burnham curated the exhibition 'Software, Information, Technology' at the Jewish Museum in New York in 1970 (La Fondation Daniel Langlois, 2004). This was followed a year later by 'Art and Technology' curated by Maurice Tuchman and Jane Livingston at the Los Angeles County Museum in 1971 (La Fondation Daniel Langlois, 2005). In 1976 Steve Jobs and Steve Wozniak started the personal computer age with their company Apple. In 1979 the Initial Graphic Exchange Standard (IGES) a neutral data format that allows the digital exchange of information between CAD systems was introduced. Ars Electronica an organisation based in Linz, Austria, was founded in 1979 around a festival for art, technology and society.

2.2.4 1980s

More CAD and CAM[8] systems were introduced in the early 1980s to partially automate the manufacturing process. By 1982 there were 17 companies offering solid modelling applications (LoPiccolo, 2002). V2_ Institute for the Unstable Media started in 1981 in the Netherlands as an artists' initiative (V2_, 2007). In the mid-1980s major technological advances were made, including the

[8] e.g. Romulus, Uni-Solid, AutoCAD, CATIA (Computer-Aided Three-Dimensional Interactive Application).

introduction of feature-based parametric modelling systems that allowed CAD/CAM software to become a more integral part of the product design process. In 1986 Ars Electronica (Ars Electronica Linz Gmbh, 2007a) become an annual event. In 1987, the organisation began hosting the Prix Ars Electronica. This period also saw the founding of the first rapid prototyping companies, Helisys[9] in 1985 and 3D Systems (the market leader) in 1986. Also in 1986 the Airbus A320 jet was developed entirely on CAD (LoPiccolo, 2002). The following year saw the founding of two other RP companies, Cubital and DTM with Stratasys following in 1988 and EOS in 1989. 3D Systems first demonstrated the Stereo Lithography Apparatus (SLA®) at the Autofact Expo in Detroit, Michigan in 1987 with the system becoming commercially available in 1988 (LoPiccolo, 2002). The exhibition 'Art & Computers' was at the Cleveland Gallery in Middlesbrough in the same year (Briscoe, Howard, Sekers, and Viner, 1988). This included the work of William Latham who was then a Research Fellow at IBM in Winchester. Towards the end of the 1980s many new CAD/CAM and 3D modelling applications appeared[10]. Zentrum für Kunst und Medientechnologie (ZKM), Karlsruhe, Germany was founded in 1989 (Zentrum Für Kunst und Medientechnologie, 2007).

2.2.5 1990s

This rate of development continued and accelerated throughout the 1990s with the release of the first versions of many of today's market-leading[11] 3D applications. Ars Mathematica was founded in Paris, France in 1992 by Christian Lavigne and Alexandre Vitkine to promote the interconnection between art, science, and technology, with a particular focus on computer-assisted sculpture. In 1993 SensAble Devices (later SensAble Technologies, Inc.) was founded by Thomas Massie and Dr. Kenneth Salisbury at MIT (SenseAble Technologies, 2007). This introduced 3D touch-enabled modelling systems that enabled users to touch and manipulate virtual objects via an articulated stylus. In 1995 Ars Mathematica and the Computers and Sculpture

[9] Laminated Object Manufacturing (LOM™) is a rapid prototyping system developed by Helisys Inc. Helisys went out of business in 2000.

[10] e.g. ANVIL-5000, DesignCAD, Ashlar Vellum, Creative Environment (later Softimage), Pro/ENGINEER, SurfCAM, Autodesk Animator, mental ray and MicroCADAM.

[11] e.g. 3D Studio (later 3D Studio MAX), Alias Studio, LightWave 3D (first shipped with Video Toaster), PowerAnimator (later MAYA), form•Z, CINEMA 4D, Sculptura (later Rhinoceros), Mechanical Desktop, Solid Works, ANVIL EXPRESS, etc.

Forum (CSF) founded by Bruce Beasly, Rob Fisher and Tim Duffield hosted 'Intersculpt 95' at the Gallery Graphe in Paris and in the Silicon Gallery in Philadelphia (Lavigne, 2007).

By 1995 reverse engineering was easier with new software that could automatically create surfaces from point cloud data obtained from 3D scanners (LoPiccolo, 2002). The mid to late 1990s saw the beginning of mass use of the Internet. The first version of Eyebeam Atelier a nonprofit arts and technology centre based in New York was founded in 1995. At the same time the Banff New Media Institute (BNMI) at the Banff Centre for the Arts in Canada was initiating investigations of 'virtual environments' (Century, 1999). Between 1997-98 the 'CALM' (Creating Art with Layer Manufacture) project was set up by the Higher Education Funding Councils as part of an initiative to promote the use of IT within the art and design community in UK higher education (Hodgson, 1998). In 1999 the exhibition 'Mind into Matter: New Digital Sculpture' curated by George Fifield and Francine Koslow Miller took place at the Computer Museum as part of the first Boston Cyberarts Festival (Boston Cyberarts, Inc., 2004). At the end of the 20th Century there was fierce competition for market share between the CAD, CAM and 3D applications. A big advantage of the newer products was they did not need to work with legacy data. Many of the newer firms were subsequently acquired by larger companies.

2.2.6 21st Century

In 2001 two major American museums held exhibitions exploring digital technology. '010101 Art in Technological Times' was curated by Aaron Betsky, Janet Bishop, Kathleen Forde, John S. Weber and Benjamin Weil at the San Francisco Museum of Modern Art (San Francisco Museum of Modern Art, 2001). 'BitStreams' was curated by Lawrence Rinder and Debra Singer at the Whitney Museum of American Art (Whitney Museum of American Art, 2001). These high profile exhibitions were followed in 2002 by 'Mood River' curated by Jeffrey Kipnis and Annetta Massie at The Wexner Center for the Arts, Columbus, Ohio (Wexner Center for the Arts, 2002). This was an exhibition that brought together both art and design objects that were characterised by waveforms – an acknowledgement of the impact of the spline in art, architecture, craft, design, aeronautics, fashion and science.

In 2005 the exhibition 'Blobjects and Beyond: The New Fluidity in Design' curated by Steven Skov Holt and Mara Holt Skov was held at the San Jose Museum of Art (San Jose Museum of Art, 2005). This was the Museum's first exhibition devoted to industrial design. In 2006 Autodesk acquired of Alias (formerly Alias Wavefront) for $197 million. In 2007 the exhibition 'Digitalability' curated by Atilano González-Pérez was held at the DESIGNMAI Forum, Berlin and explored material things, immaterial interfaces and design (Dauerer, 2007). At the time of writing (2007) 3D Systems has announced the V-Flash desktop modeller (to be manufactured by Canon) priced at $9,900 (3D Systems, 2007) and Idealab has announced the Desktop Factory 3D Printer priced at $4,995 (Desktop Factory, 2007)[12]. This might indicate a new era of desktop manufacturing if these less expensive machines are successful.

2.3 CAD/CAM and RP&M in sculpture (practitioner-led activity)

Rapid prototyping has been described as an ontological breakthrough (Ganis, 2004, p.29) bringing the virtual world of a CAD modelling space into physical space. Sculptors have been using computer-based design and fabrication tools for many years. Charles Csuri (Figure 4) was using a mathematical function stored on punched tape to control a CNC machine to make sculptural forms in 1968 (Paul, 2003 p.26).

Figure 4: 'Ridges Over Time', 1968. Charles Csuri

[12] Previously these price decreases had occurred in the 3D software market. In 2002 Alias Wavefront that had been selling Maya Unlimited for $16,000 and Maya Complete at $7,500 reduced their prices to $6,999 and $1,999 - the biggest single price cut in the history of the 3D animation market. This signified a price and feature war between the high-end 3D modelling and animation applications. In 1999 Softimage was sold in two versions: '3D extreme' at $11,995 and '3D' at $4,995. By 2004 Softimage XSI Foundation (equivalent to '3D' plus five years of upgrades) was reduced from $1,995 to $495.

However, in the early 1990s with the creation of the artist-led organisations Ars Mathématica (Founded by Christian Lavigne and Alexandre Vitkine, 1992) and the Computers and Sculpture Forum (Founded by Tim Duffield, Bruce Beasley, Rob Fisher and David Smalley in 1993) an international network of artists using these technologies was established. These organisations co-hosted 'Intersculpt 95', simultaneously in Paris (Gallery Graphe) and in Philadelphia (Silicon Gallery). During this exhibition, the first 'telesculpture' was produced in Paris on a LOM™ machine, controlled by data that Stewart Dickson sent from the US. Since then, 'Intersculpt' has become a biennial event with locally directed exhibitions happening more or less simultaneously and has grown steadily as more artists in other countries have become involved with these technologies. At the outset, there were almost as many terms for this activity as there were practitioners or forms of activities undertaken: 'digital sculpture', 'virtual sculpture', 'telesculpture', 'infosculpture', 'robosculpture' and 'cybersculpture' to name a few (Paul,1999).

Besides 'Intersculpt' there have been a few other survey exhibitions and projects that have showcased and promoted the use of digital production (particularly RP&M) technologies by practitioners. From January 1997 – December 1998 the 'CALM' (Creating Art with Layer Manufacture) project was set up by the Higher Education Funding Councils as part of an initiative to promote the use of IT within the art and design community in UK higher education.

> "To set the project in context, it should be noted that very few artists had used rapid prototyping at all; perhaps a dozen in all, worldwide. So the CALM project was breaking very new ground in trying to inspire artists to use this technology." (Hodgson, 1998)

As a direct result of the 'CALM' project, a new organisation Fine Art Sculptors and Technology in the UK (Fast-uk) was set up by Keith Brown of Manchester Metropolitan University.

'Mind into Matter: New Digital Sculpture' (Boston Cyberarts, Inc., 2004) was curated by George Fifield and Dr. Francine Koslow Miller at the Computer Museum. This was during the first Boston Cyberarts Festival May 1-15, 1999. This exhibition explored the use of RP technologies to create three-dimensional

art. The theme of the exhibition was the hybridisation between technology and traditional art processes to turn the artistic visions of the mind into matter. Eight artists from the United States and Europe participated. Christian Lavigne, Dan Collins and Michael Rees also involved in 'Intersculpt' were included as were Tim Anderson and Jim Bredt – the inventors of the ZCorp 3D printer.

'TeleSculpture' (Collins, 2005) is a biennial exhibition and series of events held at the Partnership for Research in Spatial Modeling (PRISM) Lab at Arizona State University organized by Dan Collins. In 1999, 2001, 2003 and 2005, 'TeleSculpture' was scheduled to coincide with the biennial digital sculpture event, 'Intersculpt'. PRISM was established in 1996 to foster research and the application of 3D modelling and visualisation to interdisciplinary research. As a result, 'Telesculpture' has always included objects created with a wider research-related scope than just fine art practice.

'Connectivity' (Connectivity, 2007) was a collaborative project jointly supported by Gray's School of Art, The Robert Gordon University, Aberdeen and <make> research and development unit at The University of Plymouth between Autumn 2003 – Summer 2004. The project explored the potential of digital methods of creativity and manufacture. The theme for the project was a 'sense of place'. Each participant developed an object to be manufactured by rapid prototyping within a 125 millimetre cube. Each object incorporated several magnets to provide physical connections between the finished pieces. There were sixteen invited practitioners involved from the UK, Australia, Japan, New Zealand and USA. These were selected from across disciplinary backgrounds but were mainly craft-makers.

The 'International Rapid Prototyping Sculpture Exhibition' (Visser, 2006) opened on Sept. 27, 2003 at The Sarofim School of Fine Arts on the campus of Southwestern University in Georgetown, Texas. The exhibition was initially a companion event to 'Intersculpt 2003' but has toured to several locations since. The exhibition was curated by Mary Hale Visser.

'Intersculpt', 'Telesculpture', and the 'International Rapid Prototyping Sculpture Exhibition' can be viewed as different manifestations of the same artist-led

activity. The organisers and exhibitors are drawn from the same loosely affiliated group. In her essay 'Fluid Borders: The Aesthetic Evolution of Digital Sculpture' Christiane Paul (1999) interviews many of the most prominent members of this group. This text is one of the few sources available which tries to contextualise this activity and is therefore important in identifying the issues faced by these practitioners. In this essay Robert Michael Smith indicates the hybrid nature of this activity that he terms 'digital sculpture', stating the boundaries of this activity are 'fluid' and characterises his work as 'experiments'. Paul herself points out that any digital information may be used towards multiple ends which can ultimately lead to the disintegration of boundaries between disciplines. Christian Lavigne (a computer scientist turned digital sculptor) reiterates this stating the

> "...transdisciplinary character of digital sculptors' activity tends to disturb systems that are used to separating individuals and genres". (Paul, 1999)

Dan Collins stresses that it is important to distinguish between work that is strictly experienced through the computer screen as opposed to objects that have been produced using computer-controlled manufacturing machines and are experienced through the body. Keith Brown suggests that art should transcend the medium of its making and warns against confusing technique with art by stating that

> "On one end of the critical scale, digital art is occasionally dismissed as "technology on display." On the other end, there is a danger of confusing the "WOW" factor produced by new technologies with a unique artistic vision." (Paul, 1999)

Dan Collins repeats this point by stating that

> "Most of what I am aware of being produced under the rubric of "digital sculpture" merely mimics the formal strategies of traditional sculpture" (Paul, 1999)

Many of the artists interviewed for this piece are insistent the means of production was secondary to the artistic content of their work. However, the objects produced are more about exploring the application of computer

technologies and not necessarily the grammar of the objects produced. Nevertheless, in 1999 the potential for practitioners to work across traditional disciplines by using common digital tools and the possibility of a new hybrid model of 3D art and design practice was very much part of the discourse of 'digital sculpture' among these practitioners.

2.3.1 CAD/CAM and RP&M in sculpture (beyond practitioner-led activity)

If we look beyond the 'digital sculpture' of artist-led activity discussed in the previous section, what new kinds of objects are being produced by art and design practitioners using computer-based design and fabrication tools? Through reference to key examples this section explores the conditions and means that contribute to this development. There are artists that make use of computer-based design and fabrication tools which have gained prominence beyond artist-led activity and that were exhibited in the high profile museum exhibitions mentioned previously (in section 2.2.6.)

'010101 Art in Technological Times' (San Francisco Museum of Modern Art, 2001) was curated by Aaron Betsky, Janet Bishop, Kathleen Forde, John S. Weber and Benjamin Weil at SFMOMA in 2001 and 'BitStreams' (Whitney Museum Of American Art, 2001) was curated by Lawrence Rinder and Debra Singer at the Whitney Museum of American Art New York also in 2001. Although all the artists in these shows use digital technologies the most relevant to this study are Roxy Paine and Karin Sander (010101 Art in Technological Times), Robert Lazzarini and Michael Rees (BitStreams) and Craig Kalpakjian (both).

Figure 5: 'SCUMAK' (Auto Sculpture Maker), 1998. Roxy Paine

Roxy Paine's 'SCUMAK' (Figure 5) is a computer-controlled machine that fabricates 'sculptures' at the rate of one per day from molten low-density polyethylene. The software-based part of the work controls the flow rate, its duration and the time the material is allowed to cool before more is dripped from a nozzle onto the conveyor belt below. This art-making machine removes the artist's hand from the creative process by allowing entropy to enter the design process resulting in individualised mass production. This brings into question notions of originality, authenticity and authorship that are traditionally valued in works of art. Through mechanising creativity Paine subverts ideas about uniqueness and both craftsmanship and computer-aided manufacturing.

Figure 6: 'Gordon Tapper 1:10, 3D body scan of the living person', 1999. Karin Sander

Karin Sander's '1:10' (Figure 6) consists of figures produced by 3D scanning people invited to participate by Sander. Each figure is created by a computer controlled 3D scanning apparatus that produces a data file describing in thousands of points (a point cloud) the likeness of the subject's body and clothing. The data from the scans is used to make the figures at 10% of life-size in ABS plastic (Acrylonitrile Butadiene Styrene) using a Fused Deposition Modelling (FDM™) rapid prototyping machine which extrudes a hot plastic thread to show a cross-section of the subject's body. When the figure is finished, it is then painted from photographs taken at the time of the original scan by a technician. Sander makes no decisions concerning how the subjects will stand or what they wear. All artistic decisions are made in programming the sequence of events that will result in the finished object. The result is an exhibition of figurative objects made through a conceptual programme of activity that is

executed by various technologies and leaves the objects untouched by Sander herself.

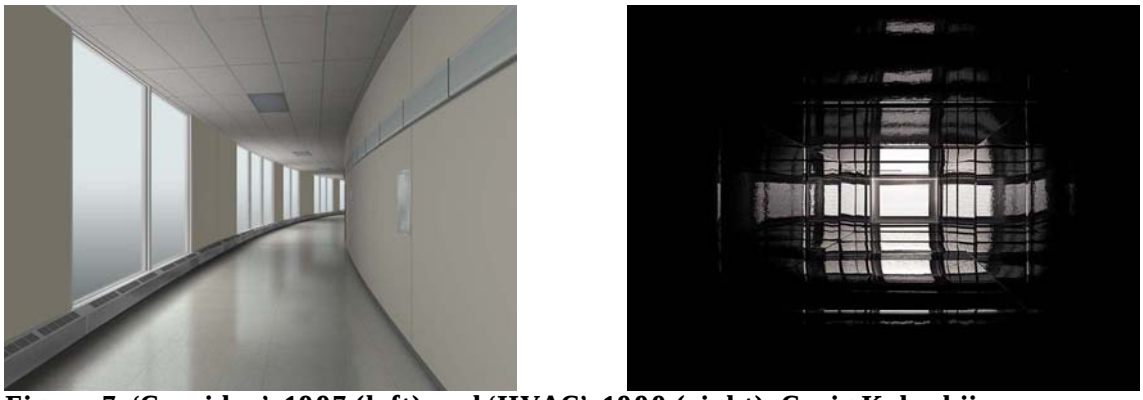

Figure 7: 'Corridor', 1997 (left) and 'HVAC', 1999 (right). Craig Kalpakjian

Craig Kalpakjian's 'Corridor' (Figure 7, left) is a digitally rendered looping animation of the passage through an empty, curving office hallway. 'HVAC' (Figure 7, right) is one of a series of cibachrome prints of renderings looking through a generic heating, ventilation or air-conditioning ducts. Kalpakjian uses CAD software to produce visualisations of impersonal spaces that reference corporate architectural interiors. These images are almost indistinguishable from the visualisations routinely produced by architects and interior designers to show how an unbuilt space could potentially look. The characteristics that distinguish these images from their commercial counterparts are the blandness of the features selected to focus on. These seemingly endless environments are disturbing in their dirt-free, computer-generated perfection and are devoid of any evidence of humanity.

Figure 8: 'Skull' (Distortion#2 of 4), 2000. Robert Lazzarini

Robert Lazzarini's 'Skulls' (Figure 8) presents four perspectively distorted skulls that brings Hans Holbein's anamorphic image of a skull from the painting 'The

Ambassadors' (1533) out of the picture plane into physical space. Lazzarini begins with a familiar object, from which he makes a digital scan and subjects the resulting mesh to dimensional distortions - he then creates a master model through rapid prototyping which forms the basis for casting the final sculptures. In the case of 'Skulls' this is in Polyester resin and bone meal.

Figure 9: 'Ajna Series' (detail), 1998-2000. Michael Rees

Michael Rees' 'Ajna Spine' series (Figure 9) of 3D computer-generated collages of body parts from Magnetic Resonance Imaging (MRI) data reference both the physical and metaphysical. 'Ajna' is the sixth chakra, or energy point that is usually referred to as the 'third eye'. These works look like strange anatomical models. In these works Rees also questions notions of craftsmanship and authorship by digitally applying the mark of his hand in the form of scanned palm prints to these objects. However, Rees is not just reinserting the evidence of haptic, craft-based skills but is also referencing palmistry by using a specific region of the hand used in divination. For the 'BitStreams' exhibition Rees presented these objects on stacked tables. As well as giving small, fragile objects a sense of presence this can be seen as playing with the traditional discourse of 'the base' running throughout Modern sculpture[13]. It can also be seen as referencing taxonomical structures (classification tables). Michael Rees is the only artist involved in both the artist-led activities ('Intersculpt', 'Telesculpture', and the 'International Rapid Prototyping Sculpture Exhibition') discussed above and these museum shows.

These artists have made physical and in Kalpakjian's case virtual objects that seek to re-examine object making using computer-based tools. These works

[13] Since Rodin took his sculpture off of them and Brancusi made his sculptures out of them.

purposely exploit computer-based technologies beyond the pragmatic aspects of increased speed and productivity. However, paradoxically in these examples the digital tools are being used in ways that are more like how the technologies would be used in an industrial or commercial context. This is a point expressed by Barbara Pollack in her review of 'BitStreams' (Art in America, September, 2001):

> "...this breed of sculpture may be new for an art museum but is barely innovative in comparison to the props and special effects routinely seen in Hollywood movies." (Pollack, 2001)

> "The curators of "BitStreams" would like to argue that digital technology creates a paradigmatic shift tantamount to the invention of photography... the exhibition merely demonstrated that artists, like everyone else, use computers. Once curators cede the intellectual high ground on this issue, exhibitions of digital art become indistinguishable from the range of products regularly on view at Circuit City." (Pollack, 2001)

Unlike the objects shown in the artist-led survey exhibitions none of these artists is showing discrete, unmodified objects. Although these objects (except for 'SCUMAK') apply the formal tactics of traditional sculpture in that they provide visual phenomena for aesthetic contemplation, these artists are making objects of a different order than those of digital sculpture. These works also question the conventional models of authorship and start to probe the scope of both digital manufacturing and the arts.

2.4 Developing critical discourse

One particular aspect of the use of 3D modelling software that is obvious from the 'digital sculpture' examples is the fact that visually complex objects can be arrived at by using pre-programmed features of the software that modify and transform an object. These objects have been compared to the objects[14] carved to show the mastery of 17th Century artisans (Ganis, 2004, p.29). In CAD applications these operations can be easily performed and can result in objects with formal qualities that are unlikely to be achieved without the aid of a computer. However, many of these practitioners are engaged in what has been

[14] Giovanni Ambrogio Maggiore in 1582 invented the art of turning one ivory ball inside another to form what has become known as 'Contrefaitkugel'.

called ‘engineer art’ (Ganis, 2004, p.30). This includes creating physical expressions of mathematical formulas, complex polyhedrons, and imagery derived from magnetic resonance imaging (MRI) or other 3D scanning technologies (Ganis, 2004, p.30). Other examples of this include the use of ‘off-the-shelf’ parametric, 3D human figure generation software and the use of freely available premodelled assets from online sources – 3D ‘clip art’ or ‘found digital object’ sculpture.

Bolter and Grusin (2000) suggest (after Marshall McLuhan) that at its inception any new medium will always ‘remediate’ (i.e. adapt, repurpose or integrate) prior media. It can therefore be viewed that the objects resulting from the initial exposure of these technologies are ‘remediated’ objects. That is the application of digital technologies has been employed to ‘remediate’ sculpture as ‘digital sculpture’. However, in these cases this remediation only applies to the conception and production of the objects. These objects are still received as static visual phenomena for aesthetic contemplation. Much of this initial work is compared to early photography (Paul, 1999 and Ganis, 2004) and it is pointed out that it took many decades for this technological innovation to be admitted to the canon of fine art practices.

> “In the life of a technology, there is an early "talking dog" phase: it would be notable if a dog could talk at all; what the dog first says wouldn't matter as much. Only later do you begin to care what the dog talks about.” (Gershenfeld, 2005, p.194-195).

Much of the discourse surrounding the artist-led exhibitions mentioned in the previous section (2.3) has been concerned with the mechanics of the digital tools. The level of critical discourse is limited. However, there are a few key sources we should consider to put this activity in context before moving on. In ‘Abstracting Craft’ Malcolm McCullough (1996) investigates the relationship between the use of digital technologies and traditional craft. McCullough argues there is little difference between established craft and digital practice with examples from various disciplines. His thesis is to reconsider CAD/CAM in such a way that they are not utilised

> "...so much for automating tasks as for abstracting craft." (McCullough, 1996, p.81)

McCullough attempts to avoid accusations of nostalgia by using the word 'craft' as a verb (McCullough, 1996, p.22) rather than noun - as 'intelligent action in a specific setting' which draws on the tacit knowledge inherent in the maker's practice. McCullough offers analysis of the technological and psychological aspects of computer use. He does this to develop a critical understanding of the ways in which the computer operates both as a medium and as a tool (McCullough, 1996, p.62). McCullough argues that this compels new creative skills and the building of mental models of objects and processes (McCullough, 1996, p.217). McCullough suggests it is the responsibility of software engineers to create less obtrusive and more transparent applications and equipment for creative users (McCullough, 1996, p.251).

In her 1998 PhD thesis Katie Bunnell describes the impact of a 'learning curve' when transitioning from material-based practice to digital practice:

> "To some extent the researcher allowed specific personal conceptual developments to be superseded by the exploration of techniques: instead of "having an idea" and then working out how it might be done, the situation was reversed into having a piece of equipment, finding out what it might do and then deciding how to use it." (Bunnell, 1998)

This appears to be a common experience when practitioners first use digital technologies. Bunnell's research project was concerned with integrating environmentally sensitive materials and processes and computer technology into ceramic designer-maker practice. This was driven by the need to position craft as a sustainable, contemporary, professional practice. The research explored the potential application of technologies through investigations into specific materials and processes. Bunnell pointed at the restrictions of access, cost and training for designer-makers as causes of the limited extent to which technologies had on the field of designing and making at that time. This research also highlighted the potential of a wider range of professional opportunities for designer-makers working in a post-industrial context. The study looks at the conventional, anti-industrial philosophy of craft practice and negative assumptions about the potential impact of computer technology on

traditional hand skills. However, Bunnell argues the creative imagination and computer skills of the user are equally implicit in the outcome and use of computer technology can be integrated as a 'craft' skill to allow for the creation of increasingly sophisticated and complex ideas and critical frameworks.

Bunnell suggests the main advantages of using CAD/CAM include:

- increased autonomy by allowing the designer-maker to give up some laborious and repetitive aspects of making to specialised machine operators without risking the integrity of their design
- the ability to produce batches of objects, or work in series as a more economically viable way of working
- the production of objects of greater complexity than could have been achieved before
- the development of new aesthetic qualities evolved through integration of new technologies
- the ability of makers to shift economic and industrial contexts beyond mass production systems towards smaller enterprises based on the skills of individual practitioners

In her presentation 'Otherwise unobtainable: the applied arts and the politics and poetics of digital technology' given in 2002 at the Victoria & Albert Museum Tanya Harrod offered some preliminary thoughts on the relationship between new media and the applied arts. Harrod said that digital technologies pose a threat to applied art practice. She speculated that applied artists would most likely use new media in functionalist ways - as a tool. According to Harrod this claim that the computer is only a tool is a cliché. She states that we know the computer is not just a tool and that use of digital technologies affects the thought processes of practitioners with traditional materials-based training. Citing the work of Roland Barthes she indicts Adobe® Photoshop® for encoding a whole range of current cultural norms and endorsing a model of authorship as selection. She states the dominant discourse around digital technologies is gendered by "futuristic cybertalk" inspired by science fiction writers such as William Gibson. Harrod then proposed a feminist reading of new media that identifies spaces of resistance and transformation and offers "mutable identities" and "unanticipated possibilities".

She continued by referencing McCullough's 'Abstracting Craft' which she states seeks to humanise the digital by comparing the use of these with the tacit skills

embodied in traditional craft practice. However, she quickly pointed out the negative aspects of the innate "audit-like" nature of human-computer interaction. Harrod then tried to identify some general principles of the creative engagement with new media as a different kind of time consumption. This includes the potential to spend more time conceptualising and less time making; and the ability to produce objects and images that could not have been made in any other way. Harrod calls this the "otherwise unobtainable".

The works in the 'MadeKnown: Rapid Prototype Sculpture' exhibition (13 Sep - 18 Oct, 2005, curated by Ian Gwilt and Brit Bunkley) represent an international survey of artists who have embraced the potentials of 3D printing to create sculptural objects. Artists from Australasia, Europe and the US were invited to send a piece of work via the Internet as a 3D digital file. These files were fabricated using the 3D printing facility in the School of Design at University of Technology, Sydney.

Although many of the participants in MadeKnown (Gwilt, 2006) are the same as the 'Intersculpt', 'Telesculpture', and the 'International Rapid Prototyping Sculpture Exhibition' the level of critical discourse around this exhibition (for example in the exhibition catalogue) is of a more developed nature. In his essay 'Techniques Matter' Andrew Benjamin distinguishes between two radically different forms of representation: what he terms the 'pre-digital' which uses the computer to represent design and 'digital practice' in which the computer itself becomes a design tool (Gwilt, 2006, p.4-5). Benjamin states that with the application of digital technologies concerns are generalised regardless of discipline and the most important relationship is between the immaterial and the material states of digital production (Gwilt, 2006, p.7).

In 'Feeling the Rub: making an ontology of painting' Mark Titmarsh asks if there is a difference between making something in particular and the universal nature of all making? (Gwilt, 2006, p.11) Titmarsh states that 'to make' is as elementary as 'to do' and 'to be'. McCullough is referenced in regard to a hybrid form of craft-based knowledge (Gwilt, 2006, p.16). Again, the issue about whether 'digital crafting' treats the computer as more than a tool or as a medium is discussed. Titmarsh argues for an embodied link between the physical

operation of the digital interface and the abstracted data. He states that from his perspective new technologies expand the possibilities of painting. Jackson Pollock and Allan Kaprow are referenced (Gwilt, 2006, p.20-21) in relation to a hybrid form of practice. The same is attributed to Richard Serra's 'Verb List Compilation: Actions to Relate to Oneself' 1967-1968[15] which is understood as the 'score' of a series of sculptural events. Titmarsh states these activities made art practice more and more performative until all that remained were events or happenings - an 'ontology of making' that generated a new sense of boundary shifting and hybrid art forms such as performance and installation.

In the same catalogue, Steve Hatzellis' essay 'Edge of Chaos' explores the relationship of architecture to complexity theory and technology. Hatzellis discusses recent architectural design projects generated by 3D animation software (such as Greg Lynn, Kas Oosterhaus, Asymptote, Zaha Hadid and UN Studio). He states these have been criticised for being unrealistic, un-constructible and incomprehensible (Gwilt, 2006, p.39). Hatzellis indicates that whilst the formal outputs from the computer in these projects are radically complex, this complexity can be too easily produced and has been accused of expressing no apparent purpose, cause or order. He points out the forms generated by animation software are the graphic constructs of mathematical algorithms - which are rational. Hatzellis states that although scripting the generation of form has the potential to produce a proliferation of outcomes; it leaves the designer with the difficult role of selecting from a multiplicity of forms. He echoes Harrod (above) by stating that this creates a cataloguing and selection process. This is stated to be a postmodern approach that Hatzellis argues should be performative and only secondarily representational (Gwilt, 2006, p.44). This new genre of architecture (that is only possible through the application of digital technologies) makes use of ideas and objectives founded in nonarchitectural disciplines (Gwilt, 2006, p.48).

This critical debate around the use of these technologies for digital sculpture is rare. Even so, these particular essays are concerned with the use of 3D modelling and rapid prototyping in relation to painting and architecture.

[15] http://www.ubu.com/concept/serra_verb.html

Obviously it is necessary to look beyond the domain of sculpture to other discourses for critical discussion.

2.5 Developments in architectural practice

The idea that one might include architecture in this study might seem problematic - given the disciplinary disputations about whether the products of some of the more experimental architects can be called 'Architecture' since there have been few buildings produced entirely by computer-based design and fabrication tools. As pointed out previously by Hatzellis (see section 2.4) architectural design projects generated by 3D animation software have been criticised for being unrealistic, unconstructible and incomprehensible (Gwilt, 2006, p.39). Kolarevic (2005) suggests there is a direct relationship between the tools architects use and the buildings they build. He argues that this is why when pens and set squares were the tools of choice buildings all tended to be rectilinear. He claims this is why 'blob' forms seem to be ubiquitous in computer-based, experimental or critical architecture practice because of the capabilities of the software used. The term 'Architecture' itself is of Greek and Latin derivation. 'Building' on the other hand has Anglo-Saxon roots. In common use they refer to the same things and are synonyms. Nevertheless, they have different connotations; 'Architecture' meaning something superior to 'building'. However, for this study 'Architecture' is considered the activity of 'designing buildings'.

The technological developments of architectural CAD with computer-aided manufacture (CAM) and the exploitation of new materials and processes have revolutionised architectural practice. Computer-based design and fabrication tools have rapidly become ubiquitous in contemporary architectural practice. The ability to generate construction information directly from design information has fundamentally changed the relationship between conception and production. The discourse around computer-based design and fabrication tools in architecture is more developed than in other disciplines. It is the job of an architect to be able to specify and communicate the description of a structure that does not yet exist to multitudes of other trades. Construction drawings and models are an integral part of this.

The introduction of CAD systems have been of great benefit to architects allowing changes to be made more quickly than could be done with hand drawn blueprints. In this sense, CAD was initially an assistive technology that enhanced the existing practices of architecture – an electronic replacement for pencil and paper. Nevertheless, 3D structures were still represented in 2D and there was still a translation process between the design process and the drawing process. However, with the development of more sophisticated 3D modelling applications architects have embraced these digital technologies to open up new investigations of form and volume.

The use and customisation of CATIA (Computer-Aided Three-Dimensional Interactive Application - originally developed for the aerospace industry) by Gehry Partners to create buildings such as the Guggenheim Museum in Bilbao, Spain and the Walt Disney Concert Hall in Los Angeles, California is well documented. Gehry's use of this software is however initially still a process of translation. The preliminary massing-model is still a handmade physical model which is digitised by a laser scanner that transmits coordinates to CATIA. This digital model can then be used to generate construction drawings, structural properties of components and schedules for the project completion. However, the use of this software allows for curvilinear shapes that would have been nightmarish if possible to implement before the arrival of CAD.

This use of software is representative of a new approach to designing and making buildings termed 'building information modelling' (BIM)[16] in which blueprints and other 2D documents are replaced by digital 3D models. Each element of the design in these cases can have information about its physical properties (such as how much weight a steel beam will support) embedded parametrically to the digital component. In this way computer-based capabilities have transformed the nature of architectural practice. Drawing, modelling, performance simulations, design collaboration, construction management and building fabrication are now routinely performed using computer-based technologies.

[16] The term Building Information Modelling (BIM) was coined by Autodesk to describe 3D object-oriented CAD.

The computer is being used as a tool for design, but also for making. This opens the possibility of fabricated buildings such as the 'Camera Obscura' in Mitchell Park, Greenport, New York completed in 2005 by Sharples Holden Pasquarelli (SHoP). This structure is conceived, produced and assembled in much the same way that a consumer product would be. It is more like a conventional product development process than typical architecture.

> "The camera obscura is the first building to be 100 percent digitally designed and computer fabricated, SHoP's partners say. Every piece of wood, steel, and aluminum - 750 in total - is custom-made and completely unique…The firm has used this approach on parts of its other projects but never for an entire structure. That makes the $185,000 camera a modest but important showcase for the firm's ambitious process, which begins with 3-D modeling software and ends with construction workers assembling the laser-cut pieces into their finished form." (Scanlon, 2004).

Scanlon (2004) points out that this process is distinct from Gehry's not only in that the process is digital from start to finish but that it is process-driven rather than shape-driven. This allows the architects to substantially reduce costs and means the building does not waste structural resources by creating functionless forms – a criticism that can be levelled at Gehry. However, SHoP must also assume greater liability for the finished construction since they are responsible for the building design and its fabrication.

The scope of how these tools are being used has been extended beyond the pragmatic aspects of merely assistive technologies. Computer-based technologies are being used as autonomous, generative tools which increase the opportunity for new architectural production paradigms, design vocabularies and methodologies (e.g. biological simulation systems such as genetic evolution and emergence). Zellner (2000) and Rahim (2002) examine the work of experimental practitioners who use digital techniques and architectural methods beyond technique-driven experiments. Similarly, Couture and Rashid (2002) with their New York-based architectural design and research practice (Asymptote) present projects that are concerned as much with light, speed and the virtual as with physical geometries and building systems. Spiller (2002) provides an overview of projects that use computer-based technologies to explore the building as more than a static architectural object and terms this

'reflexive architecture'. This refers to conceptual structures that evolve and respond intelligently to their particular surroundings and environments.

Waters (2003) has explored the impact of digital technologies on the forms of consumer products and architecture. This was framed within the capabilities afforded through the application of 3D animation and modelling software. Subsequently, Hensel, Menges and Weinstock (2004) have indicated new scientific developments in modelling within artificial intelligence and evolutionary computation that are informing not only the construction of buildings, but also the composition of new materials. Hensel, Weinstock and Menges (2006) have also reviewed the consequences of the increasing synthesis of architectural design, construction and manufacturing via computation. Leach, Turnbull and Williams (2004) and Spuybroek (2004) have explored how computer-based fabrication techniques have sparked a renewed interest in structure and a growing affinity between architects and engineers. Silver (2006) has investigated the relationship between software engineering and various disciplines that benefit from programming tools. This has focused on those practitioners that engage with programming rather than basing their work on appropriated systems designed for non-architectural applications (e.g. 3D animation applications).

Rahim (2005) suggests that computer-based design and fabrication tools have the potential to affect the wider cultural landscape in profound ways. Kolarevic (2005) has explored the implementation of computer-based technologies into contemporary architectural practice in which digital design and manufacturing technologies are radically changing how buildings are conceived, designed and produced. Perry and Hight (2006) have investigated the implications for architectural authorship through the impact of digital and telecommunications technology, the media and economies of globalisation. Specifically they have looked at how new types of architectural practice are emerging from distributed and collaborative practice.

Bullivant (2005) has explored '4dspace' in which she indicates emerging practices in interactive architecture that make use of various technologies such as sensing mechanisms as a 4th time-based dimension. She has also explored

the proliferation of 'responsive environments' - spaces that interact with the people who use them (Bullivant, 2006). She has presented the work of artists and architects working on interactive projects using dynamic media systems, wireless sensing, wearable computing and other technologies.

Digital visualisation in the form of 3D modelling, rendering, animation and real-time virtual reality is increasingly being used by architects to explore, understand and communicate spatial information. The use of this digital media permits the seamless integration of various types of data. As digital technologies and wireless networks continue to proliferate, architects engage with new representation conventions and forms of interactivity. Digital visualisation is fundamentally interdisciplinary. This opens opportunities for architects to engage in the development of new forms of technological engagement of space and in new ways beyond designing and making buildings.

2.6 A re-examination of object making from a cross-disciplinary perspective

So far, we have differentiated between two distinct modes of activity. The 'remediation' of 'digital sculpture' and the appropriation of computer-based design and fabrication tools by artists to re-examine the nature of object making. Many of the 'digital sculptors' we have looked at aspired to a model of practice that generates a new sense of disciplinary boundary shifting and hybrid art forms (Paul, 1999). However, many of these practitioners have produced objects for contemplation that surpass the formal qualities of the work produced in the 1930's by artists such as Henry Moore and Naum Gabo only in terms of more complex spatial geometry enabled by the mathematical computation of the software. They do not express alternate standards to the dominant values of established practice beyond the application of new digital tools. Although the development of these works is significant within the domain of fine art, in the current study we will set these aside for the meantime to explore cross-disciplinary developments in the field.

Diverse practitioners from across the 3D art and design making disciplines can explore the use of design computing that might allow us to reconceive the nature of a practice driven by these technologies. CAD/CAM is fundamentally

interdisciplinary in nature and as a result largely transferable across a multitude of art and design practices. This means that discoveries in one area are likely to have applications and implications within another. As these technologies become increasingly affordable and prevalent and computing enters its pervasive, networked phase (McCullough, 2004), this might mean the expectations we have of the objects we surround ourselves with might be transformed. This could afford the potential to shift economic and industrial contexts beyond mass production towards small-scale manufacturing and customised manufacture and production. It may also promote new production paradigms, design vocabularies, methodologies, hybridity between conventional subject domains and the development of new orders of object.

Figure 10: 'Camera Obscura', 2005. SHoP

For example, the previously mentioned 'Camera Obscura' (Figure 10) for Greenport, Long Island, New York by architecture firm Sharples Holden Pasquarelli's (SHoP) claims to be the first building to be entirely computer designed and CNC fabricated. The structure consists of a kit of 750 digitally designed, custom-made parts in a manner more usually associated with producing a consumer product.

Figure 11: 'Amazing Whale Jaw', 2003. NIO Architecten

Also, NIO Architecten's 'Amazing Whale Jaw' bus station (Figure 11) at Spaarne Hospital in Hoofddorp, The Netherlands was CNC machined from polystyrene and coated with polyester resin. The various parts were transported to the site and glued together, before receiving a final coat of polyester. It is the world's largest structure made of synthetic materials.

As production methods have become more sophisticated and accessible, new creative possibilities have arisen that would not have been possible previously. Nonstandard means of manufacturing and new material processes have co-evolved to allow the implementation of organic forms regardless of scale or function. These building-sized objects make use of new production processes and the exploitation of the capabilities of computer-based design and fabrication tools - both in terms of software and hardware.

Figure 12: 'Sinterchair®', 2002. Vogt + Weizenegger

Oliver Vogt and Hermann Weizenegger's 'Sinterchair®' (Figure 12) is made by the SLS® process. The product is computer-generated from input from the customer. Vogt + Weizenegger use questionnaires to find out about the

customer's preferences and therefore 'Sinterchair®' is a mass-customised object.

Figure 13: 'Tuber', 2003. FutureFactories

Lionel T. Dean's 'FutureFactories' concept creates designed objects by setting ranges within which random values (assigned by a computer) determine certain defining parameters of the objects. This allows aspects of the form of the objects to 'mutate' sequentially within certain interrelated parametric ranges. In the 'Tuber' pendant LED (light-emitting diode) lamp (Figure 13) an infinite stream of products that are subtly different can be produced using a combination of RP and parametric CAD. Each one of these tuber forms is defined by a series of cross-section circles and a surface is generated between them. These circles can be twisted, scaled and translated automatically by a set of rules defined by the designer and the rest of the model updates accordingly. Nevertheless with this particular product a substantial amount of hand finishing is required.

These are two examples of algorithmic or generative design. This can be defined as the approach of developing software processes and applications which can evolve structures and objects at various levels of autonomy, based on predetermined rules, conditions and variables. These projects indicate a level of adaptation, customisation and individualisation of objects involving the end user as a co-designer - resulting in 'tailored' objects (Devereux, 2002). Sophisticated, nonstandard production processes avoid the serial mass production model. With 'Sinterchair®' this transforms the nature of the 'third-party' of the user of the object to a co-designer through the application of computer controlled machinery with consumer input.

Figure 14: 'SLS® Dress', 2005. Freedom of Creation

Janne Kyttanen and Jiri Evenhuis's Amsterdam-based design research company, 'Freedom of Creation' (FOC) produces rapid manufactured commercial products and develops new rapid manufactured textiles. They work on self-initiated as well as sponsored projects with industrial partners and universities. The 'SLS® Dress' (Figure 14) is the world's first body fitting textile garment to be produced directly in its assembled state (Hopkinson, Hague and Dickens, 2005, p.13-16). It was produced with the Loughborough Rapid Manufacturing Research Group in collaboration with Nottingham University Composite Materials Research Group.

Figure 15: 'Kagoshima Temple', 2005. Thomas Heatherwick

Thomas Heatherwick Studio's proposed temple for Kagoshima, Japan (Figure 15) is one of this London-based design studio's projects which range from products and urban design to civil engineering and public art. Heatherwick applies his skills as a 3D designer to create urban sculptural objects and iconic and functional spaces. In the temple project, Heatherwick began working with large lumps of clay before realising that this looked like fabric. This suggested the garments a priest wears or the cushion a Buddha sits on. The final design resulted from a laser-scanned piece of fabric. The proposed building consists of

layers of plywood and glass over a frame. This represents a conceptual reverse-engineering (on an architectural scale) of digital, layer-manufacturing processes.

Figure 16: 'Alessi Tea and Coffee Piazza', 2000. Greg Lynn

Greg Lynn's 'Tea & Coffee Piazza' (Figure 16) was one of twenty-two tea and coffee services produced by invited architects for the unconventional Italian household item manufacturer Alessi. Lynn used 3D modelling software and animation processes to generate over 50,000 unique, mass-produced sets of objects for future production. The manufacturing process for the objects was adapted from recently deregulated military technology used in the production of stealth aircraft. The vessels are formed from thin sheets of Titanium using heat and pressure in a series of no more than twelve of each - allowing every set of objects to be unique.

Figure 17: 'FluxSpace 1.0', 2000. Asymptote

Asymptote - the New York based architectural design and research practice established by Lise Anne Couture and Hani Rashid created 'FluxSpace 1.0' (Figure 17) a multimedia installation using computer and projection technologies. A three-metre tall wood, plaster and latex form was equipped

with sensors which were activated by visitors to the gallery. A series of video projections created the appearance of fluctuations in the surface of the object, driven by the viewer's proximity. This interactive architectural work would appear to respond and change its physical and morphological state.

There are increasing examples of projects like these which explore the critical discourse at the intersection of intersecting disciplinary domains. This indicates a multidirectional morphing or increased fluidity between disciplines and the opportunity to create fundamentally new types of designed objects and practices that eclipse conventional models. As Greg Lynn states:

> "Many people are saying that this exhibition[17] is not about architecture but about digital technology and form, but that is just because today architects are not willing to accept the role the computer plays beyond being just a tool... The emergence of digital media spaces introduces a new field with new design issues that architects are better equipped to solve than many other designers, because virtuality has been our field since we stopped building and started drawing[18]." (Lynn and Rashid, 2003. p.84)

These practitioners are trained as architects but are engaging in a model of 3D digital praxis which explores innovative design processes and attempts to re-examine object making using computer-based design and fabrication tools from a cross-disciplinary perspective. These new models of disciplinary practice exist alongside traditional models and indeed these practitioners continue to produce buildings.

[17] The US pavilion at the Venice Architecture Biennale, 2000.

[18] "Despite the increasing rationalisation of construction processes through the use of industrialised methods and products, building remains a labour intensive activity largely informed by the circumstances surrounding the involuntary actions of the body. But these temporal concerns are no longer the direct charge of architects, whose role is now limited to the representational and legal description of the building on its site. Architects have thus become increasingly preoccupied with describing a proposed building as an abstraction rather than as a collection of processes that occur over time..." (Hoffman, 1994)

Figure 18: 'Tessagon Bowl', 2006. Drummond Masterton

3D digital objects are commonly saved as tessellated meshes in the Standard Triangulation Language (.STL file format). However, usually these triangles or facets are not visible in the finished object because of setting the export resolution or by sanding and finishing the object produced. However, craft-maker Drummond Masterton has been exploring (through the process of CNC milling) a method that exploits and reasserts this triangulation which can be painstakingly designed and controlled (Bates, 2007, p.41). Masterton claims that through this process his one-off dishes and bowls (Figure 18) achieve a level of uniqueness that comes from the maker rather than the software (Masterton, 2004 and Follett, Moir and Valentine, 2007, p.28).

Figure 19: 'Airborne Snotty Vase', 2001. Marcel Wanders

The shape of Marcel Wanders' 'Airborne Snotty Vases' captures the form of mucus particles expelled during a sneeze with 3D digital scanning. The series consists of five vases named after five different illnesses: 'ozaena', 'pollinosis', 'coryza' (Figure 19), 'influenza' and 'sinusitis' which are built in polyamide by the SLS® process. The vases are commercially available from Cappellini, Italy.

These designer-makers are exploring how the manufacturing process can be transformed into a 'making' process. The objects discussed above have been made to exploit computer-based design and fabrication tools and this presents the opportunity to reframe the activities, methods and knowledge of the makers that produced them. These contemplative, functional and interactive objects engage with innovative production syntaxes. The practitioners are actively investigating and exploiting computer technologies to achieve innovation in terms of both the conceptual design process and the designed objects produced. By engaging with new sets of technologically driven, creative, cultural and economic conditions they are stimulating intriguing alternative forms of enquiry. The potential implications of this for current professional and academic models are significant.

2.6.1 From productivity tools to opportunities for design experimentation

As we have seen with the application of computer-based design and fabrication tools, some practitioners are focusing on the exploitation of the unique features of these technologies. Nonstandard means of manufacturing and new material processes allow for the development of new skill sets and design methodologies. This presents an exciting array of opportunities. However, it raises questions for practitioners about the objects we are able to make and whether we should do so merely because we can. Our industrialised culture is closely intertwined with the production of commodities that have been designed and manufactured. Computing technologies are rapidly proliferating and under these developments many conceptual dichotomies like form/function lose their significance. The challenge we are facing is not what shape an object should be or how we are to make it but why would we want to make it in the first place and what are the consequences of its making? If we have the capacity to deliver incredible productivity, but are at loss to understand what to make and why (Thackara, 2005, p.189) we must look at the broader contexts of design and production to better understand the things we choose to make.

The conventional use of these technologies within a commercial, industrial context is concerned with the pragmatic aspect of increased speed and productivity. The implementation of CAD/CAM in mass-manufacturing has

contributed to the global spread of commercially available objects, produced anonymously by mechanised production methods based on a planned division of labour (Sterling, 2005, p10). Traditional product design has been described as operating within an incremental or evolutionary framework of object optimisation through technical problem solving together with brand awareness strategies for specific markets (Powell, 2005). However, there are increasing examples of modes of practice that are looking beyond this to what has been termed 'post-optimal design' which extends design practice beyond the size-oriented and speed-focused to explore the deeper metaphysical dimensions of objects and experiences (Chapman, 2005). As computer/practitioner interactions become more sophisticated, possibilities have shifted away from productivity tools and moved towards opportunities for design experimentation (Callicott, N., 2001; Lynn & Rashid, 2003; and Scanlon, J., 2004). Use of the technologies in these ways may involve the (nondiscipline specific) generative use of new production processes and the exploitation of the unique features of these technologies (Gershenfeld, 2005 and Hopkinson, 2005); or involve the end user as a co-designer - resulting in 'tailored' objects (Devereux, 2002); or make use of software as an autonomous, generative tool increasing the opportunity for new modes of design practice (Atkinson, 2003). We will look closer at these methods of production in the next section.

Computers have become faster, smaller, cheaper, able to process and store larger amounts of data and this has led to the creation of machines that are so small that their shape is no longer necessarily determined by their function - but by how their users operate them (Krippendorff, 1995). The fact the computer environment is now common across all disciplines provokes a convergence of software development and existing design fields (Ehn and Malmborg, 1999). As computing enters its pervasive, networked phase (Weiser, 1991; McCullough, 2004; Kang and Cuff, 2005 and Bleecker, 2006), the expectations we have of the objects we surround ourselves with might be transformed.

> "When it is written, the history of computers will, I believe, be quite simple. In the beginning was the computer. Then it disappeared. Of course, it didn't go away completely. It just dissolved. Either it became part of the physical background. Forming part of ordinary objects such as tables, chairs, walls, and desks. Or it became part of the social

> background, providing just another part of the context of work." (Brown, 1996, p.30).

Rather than having computers which are discrete objects, ubiquitous computing or 'ubicomp' (Weiser, 1991, p.94-104) is a term which indicates the integration and embedding of computational capabilities into the environment and everyday objects. Other terms for ubiquitous computing include: 'pervasive computing', 'physical computing', 'calm technology', 'things that think' and 'everyware'. Embedded technology is software or hardware that is rendered invisible by being built into in a device or system. Buckminster Fuller called this process 'ephemeralisation' (Stathis, 2000) - learning to do more with less material. The thinking behind this is that it will enable people to interact with information-processing devices regardless of whatever other activities they are involved in.

In itself, embedded technology is commonplace - we take our mobile phones, photocopiers and cars for granted. However, as devices become increasingly networked to each other and to the Internet the physical world is gaining digital qualities and the environment is becoming able to respond directly to what it senses. Jerry Kang and Dana Cuff (Kang and Cuff, 2005) indicate that 'pervasive computing' is what happens when access to the Internet is ubiquitous, embedded, and animated by using mobile, wireless devices. They also point out the Internet is invading real space as networked computing elements become embedded into physical objects and environments. Julian Bleecker describes this 'Internet of Things' (Bleecker, 2006) as a nascent conceptual framework for understanding how physical objects will occupy space and occupy themselves once networked and imbued with informatic capabilities. This is sometimes referred to as 'object hyper-linking' and extends the abilities of the Internet to objects and locations in the real world by overlaying digital information which can be read by a wireless mobile device.

Bruce Sterling's book 'Shaping Things' (2005) is a thought experiment exploring and extrapolating potential future applications of computer-based technologies. Sterling is a science fiction author best known for his novels in the cyberpunk genre. However, in this work Sterling makes wide-ranging speculations on

design, technology, economics and history. Sterling is not afraid of conjecture, supposition or eclectic language - a fact which has caused this book to be derided by more empirical or positivist commentators. Nevertheless, in the context of the present study it is a useful indication of the spectrum of ideas currently being considered for the use of computer-based design and fabrication tools towards the development of new orders of object and possible new modes of design practice.

Sterling makes a timeline of objects, starting with 'artifacts' and going through 'machines', 'products', 'gizmos', and finally 'spimes' and 'biots' (Table 1). The category of object that is of interest to this study is that of the 'spime'- a neologism, a contraction of 'space' and 'time' – the idea is you no longer look at an object as an artifact, but as a process (Alexander, 2006). This recalls Gilles Deleuze's definition of an 'objectile' (Deleuze, 1992, p.19) where objects are mediated between the virtual and the tangible and become an 'event':

> "The new status of the object no longer refers its condition to a spatial mold – in other words, to a relation of form-matter – but to a temporary modulation that implies as much the beginnings of a continuous variation of matter as a continuous development of form" (Deleuze, 1992, p.19)

Type of object	Description	Requirements	User-object relationship	Timeline
Artifact	Simple artificial objects, made by hand, used by hand, powered by muscle	Created one at a time, locally	Hunters and farmers (Makers?)	Beginning of mankind
Machine	Complex, precisely proportioned artifacts with many integral moving parts that have tapped some non-human, non animal-power source	Specialised support structures for engineering skills, distribution and finance	Customers	1500s
Product	Widely distributed, commercially available objects, anonymously and uniformly manufactured in massive quantities, using a planned division of labour	Supported by highly reliable transportation, finance and information systems	Consumers	Around World War One
Gizmo	Highly unstable, user-alterable, baroquely multifeatured objects, commonly programmable, with a brief lifespan	Commonly linked to network service providers; they are not stand-alone objects but interfaces	End-users	1989
Spime	Manufactured objects whose informational support is so overwhelmingly extensive and rich that they can be regarded as material instantiations of an immaterial system	Sustainable, enhanceable, uniquely identifiable, and made of substances that can and will be folded back into the production stream	Wranglers	About 2004
Biot	Entities that are both object and person – "shape their own shape"	A technosociety where objects are fabricated by redesigning and exploiting biochemical processes	Biot	Around 2070

Table 1: Bruce Sterling's evolution of objects (after Sterling, 2005)

Sterling's 'spimes' will be uniquely identified objects that will track every interaction throughout their life cycle. These will be self-identifying, location-aware and self-documenting (Sterling, 2005, p.77). They will change the human relationship to time and material processes, by making those processes explicit and traceable. The apparent flaw in Sterling's argument is his implicit assumption that by capturing more data about the world that we will be able to exert more power over it. Sterling's solution is to make a design problem out of it. Designers are charged with creating the systems that will manage all this data and to design the means through which human beings will interact with it[19]. This is where 'Shaping Things' gets particularly interesting for this research project:

> "The modelling arena is where I shape my things. The physical object itself has become mere industrial output. The model is the manager's command-and-control platform. The object is merely hard copy." (Sterling, 2005, p.96)

Sterling states that 'fabricators' – the likely developments of RP&M machines will produce these hard copies. However, he points out (Sterling, 2005, p.106) the virtual representations of the object are more valuable than the objects themselves. The implications of this for practitioners engaged in the design of objects are widespread. For example, Sterling points out the 'machine aesthetic' of Modernism is rendered meaningless when the machinery is as good as invisible (Sterling, 2000, p.49). Instead designers need to help users to form emotive bonds with unintelligible circuitry (Fairs, 2004). Technology-enabled objects need to be embedded, personalised, adaptive, and anticipatory (Thackara, 2005, p.196). Perhaps in developing these new orders of object and experiences the use of computer-based design and fabrication tools will form the basis for a recognisable cross-disciplinary discourse?

[19] "Speaking as Yankee pragmatist type, I think it needs less interdisciplinary hand waving and more actual hero-objects. As it is, it sounds like Steve Jobs doing an iPhone rap: "it's a browser, it's a phone, it's also an iPod," without actually having a physical device to wave at the audience. "As you all know, the only way we can possibly make this valuable and profitable <fill in blank here> is with my new craft architecture sculpture computer-science scheme." Okay, great, so what is that? It sounds like I'd write it up for MAKE magazine pronto." Bruce Sterling in an email to the researcher on 01/03/2007.

2.7 Ontologies of production: 21st Century transformations in manufacturing

> "Nanofax?"
> "Everything the name implies," says Klaus, "and considerably less."
> "What's that supposed to mean?"
> "Nanofax AG offers a technology that digitally reproduces objects, physically, at a distance. Within certain rather large limitations, of course. A child's doll, placed in a Lucky Dragon Nanofax unit in London, will be reproduced in the Lucky Dragon Nanofax unit in New York..." (Gibson, 1999, p.195)

The impact of recent technological developments on manufacturing is changing the way products are designed, manufactured, and distributed. Many of these developments are founded on the integration of computer-based design and fabrication technologies. The following sections explore some of the ways in which this is happening.

2.7.1 Desktop manufacturing

Since we saw replicators on the science fiction TV show 'Star Trek' rearranging subatomic particles to make edible food on the Starship Enterprise, it has been anticipated that we will be able to fabricate downloaded products at home. This is the logical 3D evolution of desktop publishing which allows us to create or download and print brochures and documents today. Desktop manufacturing is the ability to manufacture physical items directly from your computer desktop. This represents a trend towards wider distribution of the means of production (Rhoades, 2005). According to Kevin Carson desktop manufacturing is

> "...a catchall term for two different major phenomena, with the emphasis probably on the latter: small-scale manufacturing using Multiple-Purpose Production Technology, and what's variously called layered manufacturing or 3-D printing." (P2P Foundation, 2007)

Drawing on the study 'Visionary Manufacturing Challenges for 2020' (the purpose of which was to identify challenges and enabling technologies for manufacturers to remain productive and profitable in 2020) Lawrence J. Rhoades indicates that 'distributed digital production' will transform manufacturing from the kind we know today (Rhoades, 2005). As the use of these digital technologies has become more widespread, new companies and

indeed entirely new industries have been established to meet expanding engineering technology needs. Service bureaus that provide CAD, engineering, rapid prototyping, rapid tooling, and short-run injection moulding facilities have developed to support those companies not large enough or active enough to own their own equipment. More recently, new companies that offer these services directly to individuals by a web browser have begun to appear. Also small businesses that act as designer, manufacturer and distributor of products have been enabled by the application of computer-based design and fabrication tools. In addition, other companies that allow individual users to make use of machinery in person on a membership basis have been set up. Atilano González-Pérez (Dauerer, 2007) sets out this development, thus:

- centralised design in the industrial era, with very constrained choices for designers, and limited choices for the consumer
- a decentralised design phase, where the designer no longer designs, but creates the possibility for design for others, thereby also limiting their possibilities, and also localised in corporate sites
- fully distributed design, by the user, who is also able to have the product produced, without leaving her or his desktop.

These are some of the businesses that indicate an increasing trend towards new technology-enabled companies to shift economic and industrial contexts beyond mass production systems towards smaller enterprises based on the skills of individual practitioners (Bunnell, 1998):

Midland Park, New Jersey based eMachineShop[20] provides free design software which gives users' feedback, computes a price in seconds and allows an order to be placed via the web. Big Blue Saw[21] is in Atlanta, Georgia and brings together the Internet and computer-controlled rapid manufacturing. A part file can be uploaded and it will be fabricated and sent out in 14-21 days. TechShop[22] is a fully equipped open-access workshop located in Menlo Park, California that allows users to drop in any time and work on their own projects. TechShop provides a wide variety of machinery and tools for the open and unlimited use of its members. This includes milling machines and lathes, welding stations and plasma cutters, sheet metalworking equipment, drill presses and band saws, industrial sewing machines, hand tools, plastic working equipment, electronics

[20] http://www.emachineshop.com/
[21] http://www.bigbluesaw.com/saw/
[22] http://www.techshop.ws/index.html

design and fabrication facilities, tubing and metal bending machines, electrical supplies and tools. It also provides instructors and experts to help users with their projects.

Unto This Last[23] (the title of a book written in 1860 by John Ruskin) is a London based design shop that manufactures all their products on site. The smaller items are kept in stock for immediate purchase, and the rest of the range is 'made-to-order' within five days. Their process allows most of their products to be made in a wide range of sizes with various finishes. They describe this as a micromanufacturing system. Most products are preassembled and based on simple wooden locking mechanisms without the use of tools. Ponoko[24] is a New Zealand based company that are exploring a new approach to manufacturing. The company aims to provide a custom manufacturing process where users will upload a 3D file which then will be manufactured as a physical object. They also want to handle the marketing, sale and distribution of these objects. Ponoko launched a full service in October, 2007.

> "Desktop manufacturing brings the digital revolution into the domain of everyday things. Where once there were objects, now there are well, fabjects." (Sterling, 2004)

This raises the question that if we are freed from the homogeneity of mass-produced products that are based on a market driven by economies of volume, will creative individuals usher in the development of a new order of object?

2.7.2 Personal fabrication

Neil Gershenfeld, the Director of the Massachusetts Institute of Technology's Center for Bits and Atoms (CBA) and his students are exploring the boundary between computer science and physical science through 'personal fabrication'. Gershenfeld documents this in his book 'Fab: The Coming Revolution on Your Desktop - from Personal Computers to Personal Fabrication' (Gershenfeld, 2005). Gershenfeld has been implementing Fab Labs (fabrication laboratories) which consist of $25,000 worth of equipment: a laser cutter, a sign cutter, a CNC milling machine and a suite of Open Source software and programmes

[23] http://www.untothislast.co.uk/
[24] http://ponoko.com/

written by researchers at the CBA. Gershenfeld predicts that Fab Lab prices will follow the path of PCs. With volume production and increased demand the cost of these high-tech do-it-yourself systems could fall dramatically.

These Fab Labs grew out of an MIT course called 'How to Make (almost) Anything' in 1998. Gershenfeld was astonished when ten students showed up for every available place in the class.

> "...they were motivated by the desire to make things they'd always wanted, but that didn't exist." (Gershenfeld, 2005 p.6)

These students had skill sets that were more suited to arts and crafts than advanced engineering - which was not a disadvantage. Gershenfeld states the learning process for these students was driven by the demand for knowledge rather than the usual model which is driven by the supply of knowledge. What is important to realise from this is the students were single-handedly designing and building complex systems. This is distinct from an industrial setting where tasks are distributed over teams of specialists who collectively conceive, design, and produce a product. Furthermore, once these students had mastered a new process, they would show others how to use it. In this way, new skills were introduced through project-led learning and this knowledge was disseminated from peer to peer.

> "This process can be thought of as a "just-in-time" educational model, teaching on demand, rather than the more traditional "just-in-case" model that covers a curriculum fixed in advance in the hopes that it will include something that will later be useful." (Gershenfeld, 2005, p.7)

Gershenfeld claims that through these classes, the participating students were inventing a new 'physical notion of literacy' that was much wider in scope than the usual understanding of just reading and writing. Gershenfeld points out that 'making' has been considered an 'illiberal art' since the Renaissance. He reminds us the seven liberal arts (referring to the liberation brought through their study) are composed of the quadrivium (geometry, arithmetic, astronomy, music) and the trivium (grammar, logic, rhetoric).

> "Unfortunately, the ability to make things as well as ideas didn't make the cut; that was relegated to the artes illiberales, the "illiberal arts," that one pursued for mere economic gain. With art separated from artisans, the remaining fabrication skills were considered just mechanical production. This artificial division led to the invention of unskilled labor in the Industrial Revolution." (Gershenfeld, 2005, p.34)

Gershenfeld points out that industrial mechanisation has meant that skilled workers that once used to do many things now do only one and that thinking about how to make things became the business of specialists:

> "Designers design things, engineers engineer them, and builders build them. There's been a clear progression in their workflow, from high-level description to low-level detail to physical construction. The work at each stage is embodied in models, first of how something will look, then of how it will work, then of how to make it. Those models were originally tangible artifacts, then more recently became computer renderings. Now, thanks to the convergence of computation and fabrication, it's possible to convert back and forth between bits and atoms, between physical and digital representations of an object, by using three-dimensional input and output devices that can scan and print objects instead of just their images. These tools are blurring the boundary between a model of a thing and the thing itself..." (Gershenfeld, 2005, p.103)

Gershenfeld claims the proliferation of personal fabrication will bring about a 'continuum from creators to consumers' that will bring individual expression back into mass-manufacturing through the implementation of 3D machining and microcontroller programming. In industry computer-based design and fabrication tools are used to make prototypes: precursors of items they intend to manufacture. Personal fabrication repurposes CAD/CAM and RP&M technologies from the creation of prototype parts one at a time and uses them as a manufacturing process. At MIT engineers are developing machines that not only create polymer and metal parts layer by layer, but that also print electronic circuitry, and microelectromechanical systems (MEMS) - simple printed circuit boards. The expected result will be machines that create functional products with embedded circuitry.

Gershenfeld's book is full of examples where the Fab Lab programme has brought fabrication capabilities to underserved communities that have been beyond the reach of conventional technology development and deployment. He points out that any solutions arrived at can be developed and produced locally,

and then shared globally. Gershenfeld has since deployed Fab Labs at remote locations in places such as Norway, India and Ghana.

2.7.3 Mass-customised production

'Mass Customisation' (Davis, 1987) can be defined as a process that affordably allows mass-market goods and services to be made specific, to meet an individual customer's requirements (Tseng & Jiao, 2001, p.685). There are different models[25] for mass customisation for different products and market sectors. These are consumer-driven, and make use of technologies such as the internet or databases to deliver personalised services on a mass basis through modularisation and reconfiguration (Atkinson, 2003, p.5). The product is built with a level of customisation to satisfy the needs of the individual customer, and the cost will be relatively similar to the standard mass-produced alternative.

For example, the 'mi Innovation Center' (mIC) located on the Champs Elysees in Paris by the sporting goods company 'adidas' offers consumers customisation in technology and style to design their own 'mi adidas' footwear. These shoes can be customised both aesthetically and based on their personal fit and performance needs. This involves many embedded sensors to record the pressure of the customer's footfall and to gauge the individual's running posture. This data is captured to ensure the shoes fit the specific individual. The consumer can then customise how the shoe looks and place an order for these individually designed shoes.

2.7.4 Design to order (DTO)

This method inverts the conventional sequence of product development and manufacturing. The usual sequence of a product development process is to manufacture a product and then try to sell it. However, the Japanese company Elephant Design's process is reversed (Devereaux, 2002). They generate design ideas by conducting interviews with well-known artists and designers and asking them what sort of product they would like to have. They publish

[25] Collaborative customisation – producers communicate with consumers to determine the product specifications that best serve the customer's needs. This information is then used to manufacture a product that suits that specific customer. Adaptive customisation - a standardised product is produced but this is customisable by the end-user. Transparent customisation - producers assess customer needs and provide individual customers with unique products, without explicitly telling them that the products are customised. Cosmetic customisation - firms produce a standardised physical product, but market it to different customers in unique ways. (Pine, 1993).

information about these on their website and allow visitors to explore them. When enough people express interest in a design, Elephant displays virtual prototypes on the site and asks for suggestions on how to improve them. They take orders for these and when the number of requests for the product exceeds the minimum number required by the manufacturer it is put into production.

2.7.5 Individualised production

Individualised production involves the fabrication of tailor-made goods. In 2002, Lionel T. Dean was appointed Designer in Residence at Huddersfield University and began working on FutureFactories, a digital manufacturing concept for the mass individualisation of products.

> "In contrast to mass customisation, the 'FutureFactories' model derives no input from the consumer. Where mass customisation consists of consumer selection and specification, 'FutureFactories' allows the consumer only to select the moment at which the process of form generation is arrested. Each artifact produced is therefore a one-off realisation of the designer's formula, as interpreted by computer software." (Atkinson, 2003, p.5)

> "FutureFactories has no fixed designs. Instead of creating a single discrete design solution (or indeed a finite range of options), the designer creates a template. This template defines not only the functional requirements of the form but also embodies the character of the design. Through the design template, the designer establishes a series of rules and relationships which maintain a desired aesthetic over a potentially infinite range of outcomes." (Dean, Atkinson and Unver, 2005)

CAD software can help optimise products, eliminate production errors and reduce time to market in industry. Previously, this knowledge was integrated in the finished object. Yet, with FutureFactories the value and innovation is in the software. This change encourages us to look at the method and result of the design process differently. Undoubtedly the instances that are produced as physical objects each have aesthetic value. However, the intellectual property and the creativity of this process are located in the software's capacity to produce an infinite number of slightly different forms. This indicates a definite discontinuity with objects produced as the result of either unique craft-based or mass-manufactured processes.

"'FutureFactories' acts to blur distinctions between craft and design. If the focus of 'craft' is taken to be the conception of form leading to one-off production; and 'design' is taken to be concerned with the conception of form leading to a specification for large-scale manufacture, then the distinction between a craftsperson and a designer is clear... In this context, the definitions of 'craft' and 'design' as discrete processes become hopelessly blurred, intertwined, inextricable, and as a result, meaningless." (Atkinson, 2003, p.28-29)

"Obviously, 'FutureFactories' is not a suitable model for the production of complex technological objects (at least not yet). But the design thinking behind it, and the manufacturing system proposed fits far more comfortably within the tenets of post modernism, and the drive for individuality associated with that philosophy." (Atkinson and Dean 2003)

2.7.6 Democratised production

In 'Democratizing Innovation' Eric von Hippel (2005) argues that changes in information and communication technologies are increasingly giving users the tools (for example access to modifiable content placed in the public domain) to innovate for themselves and create the next generation of commodities and services. Hippel claims that often traditional models of innovation (manufacturer-centric) have been left behind by the distributive capabilities brought about by technological change (user-centric) and are therefore largely ineffective. These assertions are backed up with extensive empirical evidence in the form of graphs and statistics. However for this study some of Hippel's ideas and insights are more relevant.

Hippel's main proposition is the most effective source of innovation is increasingly the users of products or services, not their producers or providers. Users have a better idea of what they value from a product or service. Therefore producers and providers should develop systematic methods to tap into and encourage these user-driven improvements. The discussion of this user-centric approach in the book is restricted to niche applications which are subsequently extrapolated to indicate these methods could be applied to other mass areas of activity.

Hippel states these user-driven innovations are primarily developed by 'lead users' which are at the cutting edge of important market trends - the needs they

have now are the needs other users will have later (Von Hippel, 2005, p.22). In addition, the innovations they develop to meet their own needs will often form the basis for improved commercial products. He argues that by supporting these lead users, producers and providers increase the potential to discover innovations they can then leverage and sell to their other customers. Hippel explores why users might want custom products or services, and finds that user needs are so diverse that no standardised product can meet them all. Although this is tantamount to 'all the people some of the time, and some of the people all the time, but not all the people all the time' it is nevertheless important because it indicates there is still great potential and new opportunities for new markets.

Hippel continues by discussing the 'free revealing' of proprietary information and the means by which commercial interests can benefit from this transmission. This is illustrated with the example of academic publications. Hippel cites a study (Antelman, 2004) that provides considerable evidence that free revealing vastly increases reuse based on the number of citations of papers. Empirical studies find that articles available for free download are cited significantly more often than are equivalent articles that are available only from libraries or fee-based websites (Von Hippel, 2005, p.88).

> "Freely revealing users also may benefit from enhancement of reputation, from positive network effects due to increased diffusion of their innovation, and from other factors. Being the first to freely reveal a particular innovation can also enhance the benefits received, and so there can actually be a rush to reveal, much as scientists rush to publish in order to gain the benefits associated with being the first to have made a particular advancement." (Von Hippel, 2005, p.10)

Hippel points out that smaller enterprises and even individual hobbyists now have access to sophisticated CAD design tools for hardware and electronics (Von Hippel, 2005, p.13). He suggests that this will continue to drive innovation by users. Free Open Source Software (FOSS) projects are indications that

> "...users can create, produce, diffuse, provide user field support for, update, and use complex products by and for themselves in the context of user innovation communities." (Von Hippel, 2005, p.14)

Hippel says that this is also applicable to physical products. He states that in the future product development by users can evolve to the point of replacing traditional product development. However, because of the costs involved this does not extend to manufacturing which will continue to be done on a mass scale by manufacturers. Nevertheless, he is quick to specify that during the design stage, physical products exist as information encoded in CAD files (Von Hippel, 2005, p.104). Users have access to software and hardware that is as good as those available to professional designers and can use these to manipulate, combine and adapt this information to their own requirements. Hippel refers to these 'lead users' as 'user-designers' (Von Hippel, 2005, p.156).

2.7.7 Open Source and crowd-sourced design

The term 'Open Source' is most commonly applied to the source code of software that is made available to everyone and allows for the appropriation and sharing of this content. This gives permission for users to create user-generated derivations both individually and collaboratively. 'Crowdsourcing' is term for a business model in which a task is outsourced to a large group of people usually via the Internet. The developments discussed above allow for open-source and crowd-sourced design. The following might be an indication of a developing trend in this area.

'MAKE'[26] is a magazine that publishes instructions for DIY technology projects that also has a large online community. 'Instructables'[27] is a website-based system for documenting the sequence of steps that are undertaken to make any particular thing or do any task. This can be understood as an Open Source approach. Drawing on developments in Open Source Software, blogs, wikis, and version control systems 'Instructables' is a growing resource of information about making a wide variety of things. Similarly, 'foldschool'[28] is a collection of free plans of cardboard furniture for children. These downloadable patterns can be printed out and assembled to create pieces of furniture.

[26] http://www.makezine.com/blog/
[27] http://www.instructables.com/
[28] http://www.foldschool.com/

As the use of computer-based design and fabrication tools have become more widespread, so new enterprises have been established to meet the engineering technology needs of diverse industries. This has introduced a more distributed model of digital production that more readily affords small scale manufacturing and customised manufacture. New production paradigms have brought producers and consumers into a closer relationship which has challenged conventional models of authorship as well as existing industrial and pedagogic models. New communities are developing around the appropriation and sharing of user-generated content and knowledge. It is logical to speculate that 3D printing will develop in a similar way to desktop publishing and eventually allow a mass audience to manufacture physical items at home directly from the computer desktop. These developments introduce the potential wide distribution of objects whose function is not defined by the values of established design discourses. It also implies new modes of consumption for audiences, users and/or co-creators of these objects.

2.8 A critical challenge to disciplinary domains

With the use of computer-based design and fabrication tools, diverse practitioners from across the 3D art and design making disciplines are exploring the potential for future applications outside conventional manufacturing. Michael Century (Century, 1999) points out that software applications that converge and integrate data from various disciplines constitute the first technology capable of bringing us closer to the idea of the Gesamtkunstwerk or 'total work of art' (a term attributed to the German composer Richard Wagner) meaning an artwork which is a synthesis of music, theatre, and the visual arts. Katherine McCoy (McCoy, 1997) states that convergence may be the dominant design paradigm for the current, electronic era – she claims that design disciplines and technologies are converging into each other. Furthermore, she states that CNC machining, and CAD/CAM are both productive tools and change agents. This development is significant as it suggests expanded opportunities for practitioners and the possibility of developing a 3D digital praxis which draws on the critical discourse of intersecting disciplinary domains.

Foucault (1977, p.113-138) discusses the idea of a 'transdiscursive position' - those who are initiators of discursive practices, not just of individual texts. Fundamental to this study, is the notion of cross-disciplinarity as a means to make meaningful evaluations of a new order of object across domain-specific boundaries. We have already seen in Christiane Paul's essay 'Fluid Borders: The Aesthetic Evolution of Digital Sculpture' (1999) that a new sense of disciplinary boundary shifting and hybrid art forms have been part of the discourse surrounding the activity of practitioners seeking to re-examine object making using computer-based design and fabrication tools (see section 2.3). This section of the review looks at the nature of how the use of design computing might let us look again at the nature of a practice driven by these technologies. If we suggest that this presents a new territory and the potential hybridity between conventional subject domains we must explore specifically how this might occur and what implications it might have.

2.8.1 Modes of knowledge production

In 'The new production of knowledge' published in 1994 Michael Gibbons and his co-authors introduced the notion of mode 2 research, which is newly emerging, context-driven, problem-focused and interdisciplinary knowledge production. This he and his colleagues distinguished from traditional mode 1 research, which is academic, investigator-initiated and discipline-based (Gibbons et al, 1994).

Gibbons, et al categorise three types of research beyond standard disciplinarity. These are: 'multi', 'inter' and 'trans' disciplinarity. Multidisciplinary research is characterised by the autonomy of the various disciplines involved whose theoretical structures are not changed by the new work. This can be viewed as cross-disciplinary cooperation within which the different disciplinary perspectives are maintained. Interdisciplinary research is characterised by the explicit formulation of discipline-transcending theoretical structures such as terminology or a common methodology. This can be viewed as cross-disciplinary cooperation within which a common framework is shared by the different disciplines in relation to their individual themes. Transdisciplinary research is based on a common theoretical understanding accompanied by a mutual interpenetration of disciplinary epistemologies. This can be viewed as

cross-disciplinary problem solving which results in homogenised theory or models.

Multidisciplinarity	Interdisciplinarity	Transdisciplinarity
Characterised by the autonomy of the various disciplines.	Characterised by the explicit formulation of a uniform, discipline-transcending terminology or a common methodology.	Research is based upon a common theoretical understanding.
Does not lead to changes in the existing disciplinary and theoretical structures.		Must be accompanied by a mutual interpenetration of disciplinary epistemologies.
Cooperation consists in working on the common theme but under different disciplinary perspectives.	The form scientific cooperation takes consists in working on different themes, but within a common framework that is shared by the disciplines involved.	Cooperation in this case leads to a clustering of disciplinary rooted problem-solving and creates a transdisciplinary homogenised theory or model pool.

Table 2: Three types of research beyond standard disciplinarity (after Gibbons et al, 1994)

Gibbons, et al. identify a fundamental change in the ways that scientific, social, and cultural knowledge are being produced. The basic qualities of this new production of knowledge are: complexity, hybridity, non-linearity, reflexivity, heterogeneity, and transdisciplinarity. This hybridisation reflects the need to accomplish tasks at the boundaries and in the spaces between different communities (Gibbons, et al 1994, p.37). These enable collaboration, integrative problem solving, and development of new hybrid fields. 'Mode 1' is concerned with first principles[29] in which questions and problems are dealt with in a context governed by the largely academic interests of a specific community of practice (CoP). 'Mode 2' research is based on a context of application in response to the demand for solutions to problems from a community of interest (CoI). The first mode of research is primarily disciplinary in nature whereas the second is characterised as being transdisciplinary in nature.

[29] A first principle is one that cannot be deduced from any other.

Mode 1	Mode 2
problems set and solved in a context governed by the, largely academic, interests of a specific community	knowledge is carried out in a context of application
disciplinary	transdisciplinary
characterised by homogeneity	characterised by heterogeneity
hierarchical and tends to preserve its form	heterarchical and transient
quality control less socially accountable, more related to the discipline	quality control more socially accountable and reflexive

Table 3: Fundamental differences in the ways that knowledge is produced (after Gibbons et al, 1994)

2.8.2 Modes of disciplinarity

Previously, models of scientific research have amplified the tendency for knowledge to pile up in vertically specialised 'silos' (Thackara, 2005, p.189). This structure has been held responsible for perpetuating divisions between domains that isolate knowledge from the contexts in which it is can be used. Technology transfer between differing industries driven by mass availability of computing has expanded the range and scope of many disciplines through the activities of individuals in partnership with technology, rather than a subscription to an institutionalised knowledge base (Callicott, 2001, p.64). It has been indicated (Cox, 2005, p.33) that multidisciplinary professional communities of knowledge exchange might provide an alternative to this model (Thackara, 2005, p.216).

In Klein's review of interdisciplinary practices (Klein, 1990) it is stated that theories and models from other disciplines can provide a framework for integrating diverse elements not available from standard disciplinary resources. In 'Notes Toward a Social Epistemology of Transdisciplinarity', Klein (1994) informs us that several theorists[30] are credited with coining the term 'transdisciplinary' although Erich Jantsch (1972) is most widely associated with the idea. Klein states the need for transdisciplinarity arises from developments that can be characterised by complexity, hybridity, non-linearity, and heterogeneity. Klein points to increasing globalisation of economic activities, information technologies and networks as being symptoms of Postmodernism. This she claims has led to increasing de-differentiation, de-insulation, and

[30] e.g. Jean Piaget and Andre Lichnerowicz.

hybridization of cultural categories. She indicates that transdisciplinary research requires the development of a common conceptual framework and a common vocabulary among contributors. However, she warns against the creation of self-imposed borders or the promotion of comprehensive worldviews which she states risk becoming monolithic projects or closed systems.

Kerne (2006) argues the use of 'trans' in relation to disciplinarity is still lacking a sense of how processes of disciplinary recombination are a formula for creating new knowledge. Nicolescu (1993) states that use of the prefix 'trans' indicates concerns which are at once between the disciplines, across the different disciplines, and beyond all discipline. Kerne continues to point out the structures and processes that catalyse this type of integration are still largely undefined and argues for a structure of metadisciplinarity that connects theory and practice and creates hybrid forms. Dr. Wendy Russell of the Department of Biological Sciences at the University of Wollongong states that transdisciplinary research involves the

> "...integration of different bodies of knowledge, the synthesis of new approaches and techniques of inquiry and the communication of specialised knowledge across disciplinary boundaries and beyond." (Russell, 2000)

Attfield (2000, p.1) goes even further in her study of the material culture of everyday life stating that to go beyond conventional design studies she takes a 'post-disciplinary' approach which allows her to draw upon social history, anthropology, archaeology, sociology, geography, psychoanalysis and general cultural studies.

There are obviously a plethora of approaches to research that claim to be across, beyond, and over disciplinary boundaries. Mansilla and Gardner (2003) have identified several challenges to interdisciplinary work. They point out that individual disciplines often adhere to contradictory standards of validation to those of interdisciplinary work that draws upon them. Their research indicates that for new areas of study with no existing precedents (such as in the present study) that developing validation criteria is part of the investigation process itself. Correspondingly, an aim of this study is to establish a clearer

understanding of significant characteristics of the objects resulting from the use of computer-based tools in object-making within art and design practice.

2.8.3 Boundary objects

Arias and Fischer (Arias and Fischer, 2000) state that when a domain reaches the point where the knowledge necessary for professional practice cannot be acquired in a decade, specialisation will increase, teamwork becomes a necessity, and practitioners will make increasing use of distributed cognition[31]. As was mentioned (in section 2.5) Perry and Hight (2006) have explored this aspect of contemporary architectural practice. Friedman (2000) has described the contemporary professional field of design in similar terms.

Communities of practice are made-up of practitioners (i.e. architects) who work in a certain domain doing similar work (Arias and Fischer, 2000). A community of interest involves members of distinct communities of practice coming together to solve a particular problem of common concern (Arias and Fischer, 2000). A community of interest can expect to face more communication problems than a community of practice (i.e. an architect working with a ceramicist on some architectural plasterwork).

Members of communities of interest such as those working with computer-based design and fabrication technologies can learn from others who have a different perspective and perhaps a different vocabulary for describing their ideas and establish a common ground and a shared understanding (Arias and Fischer, 2000). This could be described as a 'transdisciplinary design discourse'. One way of establishing this common ground and shared understanding is to make use of 'boundary objects' that provide a means to communicate and coordinate between the various communities of practice that make up the community of interest. Boundary objects perform a brokering role (Arias and Fischer, 2000) involving translation, coordination and alignment between the perspectives of specific communities of practice.

[31] Distributed cognition is a branch of cognitive science that proposes that human knowledge and cognition are not confined to the individual but are rather distributed by placing memories, facts, or knowledge in the environment (e.g., bound up in other people or embedded in media).

> "Boundary objects are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable means of translation. The creation and management of boundary objects is key in developing and maintaining coherence across intersecting social worlds." (Bowker & Star, 1999, p.297)

It is a goal of this research to demonstrate there is a significant body of exemplary 'boundary objects' (physical objects in this case) that can be recognised and understood across the discourse communities that are addressed in this research. The community of interest which this research addresses form a discourse community of practitioners made up of art and design practitioners that apply industrial technologies to unconventional or experimental ends. Each of these distinct communities of practice has a certain amount of shared understanding, common points of reference and an ongoing domain-based discourse. As has been stated this research seeks to indicate a common conceptual framework and a common vocabulary among the constituent practitioners in this area of enquiry. However, can the resulting 'boundary objects' that collectively contribute to the cross-disciplinary body of knowledge bring these discourses together?

2.9 A critical examination of hybrid forms of practice

The focus of this research is to explore and evaluate work happening across traditional disciplines through the use of common digital tools and determine if the work being produced in this manner signifies a trend towards a new hybrid model of 3D art and design practice. We have seen various models of cross-disciplinarity that may provide us with the means to make determinations about types of hybrid art and design practice. However, we should review in more detail how this might yield a greater integration between the 3D art and design disciplines.

The notion of a 'hybrid' art and design practice makes use of a biological metaphor. The researcher is using the word 'hybrid' in this sense to indicate the increasing predisposition and ability of creative practitioners to work across two or more creative domains and the potential of emergent synthetic or pluralist

forms of practice from this activity. Let us extend this metaphor as a thought experiment. Genetics is the science of genes, heredity, and the variation of organisms. Reproduction and mutation create variation in the gene pool of a species. This variation over generations results in adaptation and evolutionary change. Adaptations enable living organisms to cope with environmental stresses and pressures. If we apply this biological metaphor to art and design practice it raises some questions. What forms of hybrid practice exist? What might the benefit or detriment of this be to the practitioner and the parental disciplines? Is hybrid practice an adaptation to the creative stresses and pressures of the 21st Century?

Before beginning a discussion of what is meant by 'hybrid' art and design practice some thought must be given to the distinctions between 'art' and 'design'. Britannica Online states that art and design exist within

> "...a continuum that ranges from purely aesthetic purposes at one end to purely utilitarian purposes at the other." (Encyclopaedia Britannica, 2007)

Most simply, this comes down to a question of intent - does the maker intend the work to be a piece of design or a work of art? 'Art' is commonly understood to be the result of human creativity which has some perceived quality beyond its usefulness - usually based on aesthetic value, reflexive or emotional impact. There exists no general agreed-upon or satisfactory definition for 'art'. This is in part because it is a subjective and dynamic determination:

> "...art is an action, an object, or a collection of actions and objects created with the intention of transmitting emotions and/or ideas." (http://en.wikipedia.org/wiki/Art)

There are also strongly contested oppositional arguments to what constitutes design. This is most recently illustrated by the disagreement at London's Design Museum between ex-Chairman, James Dyson and Director, Alice Rawsthorn (Fairs, 2004). This collision of ideologies appears to have emerged out of a tacit, redefinition of what design can be; from an expanded perspective and because the impact of a transition to an information-based economy. Contemporary design in this sense has long since broken with a narrow

association with function (Fairs, 2004). It has been suggested that design forms the meeting of art and everyday life and that industrial design is the real visual art of the 20th Century (Poynor, 2005). There appears to be a widespread assumption that designed objects perform functions while art objects somehow transcend function (Moreno, 2005). Usually a designer must contend with the requirements of a client's brief and the concerns of function while artists enjoy more autonomy:

> "This is the contrast usually made between the roles of designer and artist: the designer must deal with matters of practicality and function while artists are free to do what they like in pursuit of their self-chosen goals." (Poynor, 2005).

However, maintaining a career as a self-employed, professional, contemporary artist that produces physical objects entails running a business and everything that entails (studio overheads, dealing with suppliers, employees, shipping and transportation, etc.)

> "…contemporary artists are not secluded in a garret; they have long employed often-immense cadres of studio assistants, thus approaching the model of a design atelier; and thanks to corporate commissions they are frequently just as bottom-line-driven as design shops." (Elfline, 2004).

The definitions that separate artistic practice and design practice are in certain instances becoming increasingly difficult to define. A recent issue of Icon Magazine (Bates and James, 2006, p.104-114) highlighted the fact that designers are increasingly producing work that aims to shock and undermine in ways that would more often be expected of contemporary works of art. This is attributed to a need among designers to comment on the state of the world and to differentiate them in a saturated marketplace. Alex Coles has pointed out the relationship between design and art is essentially one of the degree of overtness with which an artist is willing to acknowledge

> "…all art is designed, even if it endeavours to appear otherwise." (Coles, 2005a, p.10)

In this sense 'design' is distinct in that the term itself is used as both a noun and a verb, placing emphasis on what practitioners do, rather than what they produce (Flusser, 1999 and Fairs, 2004). 'Art' and 'architecture' are products - whereas 'design' is a process by which aesthetic, cultural, social, technical and economic potential is imagined and then translated to give order to objects, environments and activities. Macdonald (2005) argues that design is no longer discipline or media-based and is a quality and a way of thinking and doing. Friedman describes design as

> "…an interdisciplinary and integrative process constituting a professional field and an intellectual discipline." (Friedman, 2000, p.5)

The term 'design' is derived from the Latin signum, meaning 'sign.' Therefore, etymologically, design means 'de-sign' (Flusser, 1999) the removal of extraneous signification leaving only what is desired. Friedman locates the origins of design in craft practice and guild tradition with the first cited use of the noun 'design' occurring in 1588 (Friedman, 2000). He claims the evolution to a distinct practice of design happened only in the aftermath of the industrial revolution, and asserts the move from a practice to a profession is an innovation of the 20th Century. He stipulates there is an ongoing debate whether the arena of 'design knowledge' constitutes a discipline, a field, or a science[32].

Craft practice is another area that is undergoing self-examination (Connectivity, 2007 and Follett, Moir and Valentine, 2007). Craft is usually used to describe creative practices that traditionally are defined in relationship to the use of specific media such as: wood, clay, glass, textiles or metal. Bunnell (2004) makes the point that craft is also both process and product. However, Robert Aish makes a distinction between design and craft:

> "We can characterize design as being different to craft (because the designer does not directly act on the material, but has an indirect, and arguably more powerful, way of controlling materialization)." (Aish, 2006, p.203)

McCullough (1996) defines 'craft' as 'handskills learned by doing'. Jackson (2004) points out the implication is the use of the hands

[32] A discipline is normally characterised not by its domain of application but by the way in which it gains knowledge.

> "...excludes the mind (the exclusive realm of Art with a capital A), whereas design fosters rationality because it serves machines and the marketplace." (Jackson, 2004)

This illuminates why many contemporary craft practitioners prefer the designation 'designer-maker', indicating a production that is

> "...distinguished by a particular creative approach in which designing and making activities are fully integrated and intrinsic to each other." (Bunnell, 1998)

White (2004) has examined the impact of digital tools on her craft practice. She indicates that computer-aided design has created a new dialogue within her practice. She points out that like many other craft makers her engagement with digital technologies has been intuitive and characterises this as 'technological opportunism'. She claims that this has resulted in a hybrid practice of art, design and craft. White indicates the objects she has produced are out with the mainstream of contemporary jewellery and craft. However, she states the process she undertakes is firmly rooted within it. She warns us that a hybridised form of practice is in danger of becoming

> "...a no-man's-land of creative self-identity - a philosophically rootless post-modern condition of unmoored values, meanings and judgements." (White, 2004)

These are valuable insights that raise provocative questions about a maker's concerns with 'what' an object is in relation to 'how' it is made. Visual computing and digital tools can transform former design processes into new ways of working. The work happening across disciplines might be more clearly seen as attempts to bring about new types of critical, cultural, and technological objects around which affinity groups can form through a relationship to a common class of problems and a common pursuit of solutions. Collectively, these might represent an expanded cultural field beyond each of the traditional disciplines.

2.9.1 Art's ontological privileges

'Art' appears to be the most privileged term here. The designation of something as a work of art seems to imply some form of transcendent value. Stephen Wright (2000) indicates that for Adorno, art was not merely useless, but was somehow 'radically useless' and therefore performs as a means of subversion in a world of functionalist logic and utilitarian rationality. Wright finds this point of view dissatisfying and calls for a more discerning understanding of utilitarian rationality that acknowledges both art's use-value[33] and its difference from the 'merely useful'. Wright states:

> "...that art's use-value is inseparable from its heuristic value - that is, its ability to foster discovery, draw attention to the overlooked." (Wright, 2000).

In addition, formalists such as Michael Fried have tried to undermine the place the process of design has to play in art. In the theory and criticism of Michael Fried (1967) the term 'objecthood' is used as the antithesis of art. Fried sets up a system in which art objects are autonomous from the everyday world. Fried's claims about 'objecthood' are formulated in regard to what he claims is 'Literalist' art (which has since become known as 'Minimalist' art). This work is created with an acknowledgement of its existence as 'merely' or 'just' being an object. Fried claims that this Minimalist art is a deviation from the normal condition of art. Tony Gibart (2002) points out that 'art' and 'objecthood' form a dichotomy of classification that is dependent on whether the objects exhibit the qualities of banal, everyday objects or have been made to transcend these qualities. Fried's analysis of Minimalism is that it is art that wants to be considered in the domain of the everyday as opposed to in the reified conditions of the art world. Fried's argument is an attempt to maintain a distinct category of art object which takes on a transcendental significance.

'Aura' was the term used in 1936 by Walter Benjamin (Benjamin, 1992) to convey the sense of awe created in an audience by unique objects such as works of art or historically significant artifacts. Benjamin maintains that mass production and technologies of reproduction jeopardise notions of 'authenticity'

[33] The concept of 'use-value' was introduced by Karl Marx in opposition to 'exchange value'.

causing a loss of this 'aura'. Benjamin suggests that this loss of aura renders access to cultural objects more democratic and engenders a more critical attitude towards them. However, he also fears that in substituting a plurality of copies for a unique object detaches the reproduced object from the domain of tradition. Benjamin discusses the historical counterpoint to this - the idea of 'pure' art (the doctrine of 'art for art's sake') - as a 'negative theology' that denies any didactic or social function for art. Benjamin cites the work of the Dadaists as exemplary in degrading the aura of the work rendering it useless for 'contemplative immersion'.

The idea of 'art for art's sake' is a strictly Modernist phenomenon grounded in the philosophical system of Immanuel Kant (Jenkins, 2003). The first use the phrase '*l'art pour l'art*' is thought to be in the journal entry of Benjamin Constant dated February 11, 1804 (Jenkins, 2003). Witcombe (2000) divides Modernism into two subcategories: progressive and conservative. He asserts that conservative Modernism looked to the tradition of the institutionalised art academy and demanded art with a purpose to instruct, delight, or moralise. Progressive Modernism (which came to be referred to as the avant-garde, see below) was concerned with artistic freedom and the political and social agenda of making the world a better place for the future (Witcombe, 2000). Art historical texts from the turn of the 19th to the 20th Century discuss art in a formalist way free from not just the rules of the academy, but from the demands of the public (Witcombe, 2000). Before this, the value of works of art had been primarily regarded as either utilitarian or ornamental (Jenkins, 2003). This subsequently manifests in the Modernist notion that art objects are to be viewed in isolation from the everyday world and that questions asked of art may only be answered on art's own terms (Greenberg, 1965, p.774).

2.9.2 Beyond binary classification

Traditionally, Western thought tends to be based on dyadic opposition (thesis-antithesis) whereas Eastern thought is conceived on a triadic relationship (thesis-antithesis-synthesis) (Kim & Gaffikin, 2005). This is supported by the notion of transdisciplinarity (see section 2.8.1) as

> "...a redefinition of Aristotelian logic to include a "law of included middle", instead of a law of excluded middle, and a recognition of complexity as a fundamental feature of knowledge." (Janz, 1998)

From a theoretical perspective the binary point of view of either 'art' or 'design' is oversimplified. It is contingent upon constructing in our minds a switch with 'art' at one pole and 'design' at the other. Even from an art historical point of view this uncomplicated state has been undermined (at least) since 1917[34]. This was when Marcel Duchamp resigned as Director of the Society of Independent Artists after a dispute with the Board over whether a 'ready made', mass-produced object (a urinal) titled 'Fountain' (Figure 20, right) and signed 'R. Mutt' by Duchamp was art, or not. Abbate (2004) has stated that Conceptual Art represents a concerted effort to eliminate 'the aesthetic' as a meaningful category in art. He asserts that Marcel Duchamp laid the foundation for this by splitting apart the artwork into its ideational and material components. The readymade presents us with a generic thing, isolated as a conceptual framework from its materially specific component (Abbate, 2004). In Heideggarian terms (Heidegger, 1976, p.33) this is an 'equipmental' thing, an object whose meaning is completely exhausted in the relation of its form to its use. Abbate continues that the readymade reduces the art object to a function of its ideational content - that it is 'merely' a work of art.

Figure 20: 'Bicycle Wheel', 1913 (left) and 'Fountain', 1917 (right). Marcel Duchamp

In a Lecture at the Museum of Modern Art, New York, in 1961 Marcel Duchamp stated that:

[34] In real terms since 'Bicycle Wheel', 1913 (Figure 20, left). However, Duchamp began using the term 'readymade' in 1915 to refer to found objects chosen by the artist as art.

> "...the creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualification and thus adds his contribution to the creative act". (Duchamp, 1961)

And he continued to reclaim vast swathes of objects from 'The History of Art' into everyday life as readymades:

> "Since the tubes of paint used by an artist are manufactured and ready made products we must conclude that all the paintings in the world are 'readymades aided' and also works of assemblage". (Duchamp, 1961)

This is a characteristic which stands in stark contrast to the definition stemming from Kant's 'purposeless purpose' as a feature of our engagement with art. Kant argued that art, unlike design, could not be evaluated and understood based on its objective purpose. Kant's intention was to preserve art from the 'merely useful'. Wright (2000) claims Duchamp saw this as a way of 'de-signing' art, of removing the artist's authorial signature by using an artwork to produce a use-value. Comparing a readymade to 'mere real things' in this way is a method of exposing art's ontological privilege. In these instances it is the audience's perception of the object and its cultural context that is transformed rather than the object.

The term 'multiple' used to indicate an artwork that is produced as a number of copies (lacking of uniqueness but not as a series of editioned, unique casts or prints) was first used in the 1960s. Stephen Bury in discussing artist's multiples (Bury, 2001) claims that after industrialisation artists could take on the role of fabricator and employ the materials and methods of industrial production, or become the designer of a work of art that would be manufactured by someone else in the same manner that everyday goods are produced. Bury claims that artist's multiples question what has traditionally been acceptable as art. Bury contends the 'readymade' is usually thought of as the opposite of an artist's multiple. Readymades import the everyday into art whereas the multiple exports the art object into everyday life.

Figure 21: 'This Is a Lamp', 2001. Tobi Wong

A practitioner whose work consciously exploits the border area between these is New York-based ex-artist[35] Tobi Wong. He has coined the terms 'paraconceptual' (of, relating to, or being conceptual) for his original productions and 'readydesigned' to describe the products he creatively reworks (after artist M. Duchamp's term 'readymade' meaning art created from common objects that are not normally considered art). The objects explore the visual language of consumerism and they are often amusing. Such as the case of Wong's reworked Bubble Club Armchair (Figure 21) by Philippe Starck for Kartell. Wong has exploited the translucent qualities of this polyethylene chair by turning it into a lamp, titled 'This is a Lamp'. A reference to the Surrealist painting 'The Treason of Images' (Figure 22) which shows a pipe with the text (in French) 'this is not a pipe' by René Magritte, 1928). Wong's work

> "...is about reconciling cultural commentary with aesthetics, so that even those who don't want to dissect the concept can enjoy the object - objectively... he is happy to admit that he absorbs and digests everything around him and that his work is a byproduct of this digestive process... Wong is using design as a vehicle for art and art as a material for design." (Moreno, 2005)

[35] See also 'ex-designer' Martí Guixé.

Figure 22: 'The Treason of Images', 1928. René Magritte

This leads us to consider that cultural artifacts cannot be judged solely on the perceived intention of their maker (which might not be available or apparent), but on the wider context within which the objects are produced, consumed and used. From this point of view the world of objects is much more like a sliding scale with easily discernible 'art' and 'design' at both ends and a plurality of composite forms between. This synthetic approach can be seen in regard to Material Culture which has become an established field within cultural studies (Miller, 1998 and Attfield, 2000). Material Culture is the study through artifacts of the values, ideas, attitudes, and assumptions of a particular societal group. The theory underlying this is the objects we make reveal the belief patterns of the makers, customers, and users of the objects and the cultural values of the wider society. From this view, the products of each of the indicated disciplines of building design, sculpture, craft and product design can be seen as subdisciplinary parts of a larger totality. This more clearly reflects the continuum (indicated above) that ranges from purely aesthetic purposes at one end to purely utilitarian purposes at the other. It also places a far greater import on the reception of the object by users or audience (see section 2.9.5). Design, architecture, craft and art may be discrete disciplines, but they have common characteristics that bring them into relation with one another. This research seeks to identify those common characteristics arising from the use of computer-based tools.

2.9.3 Postmodern reappraisals of Modernist ideologies

As has been stated previously, this is not the first time that creative disciplines have had their boundaries blurred (see section 2.2). The functionalist philosophy of design as espoused in the Bauhaus dictum 'form follows function'

does not take into consideration 'aesthetic function' as anything useful. In the 1908 essay 'Ornament and Crime'[36] written by Adolf Loos (reprinted in Gorman, 2003, p.74-81) the decorative aspects of art, architecture, and design, were deemed degenerate and unnecessary. Loos' argument is that ornamentation can cause objects to go out of style and thus become obsolete. Loos made a moral imperative out of his theory that the disciplines must be kept apart to limit the propagation of decoration. Since the successful proliferation of this dogma through most of the 20th Century (Coles, 2005b, p.22-23) the more speculative aspects of design have been minimised in mainstream design discourse, education and in ideas of what makes 'good design'[37]. That is, until more recent reappraisals of the major tenets of Modernism.

Tomes and Armstrong have proposed that conceptions of 'good design' can be understood as a set of compromise positions on three dimensions of self-expression: for the maker of the designed object, for its user and for its designer (Tomes and Armstrong, 2003). They emphasise that every era, school of design and philosophical perspective takes up a particular position on these compromises, and that position forms part of its idea of 'good design'. However, they make a convincing argument that taking an extreme position in opposition to a prior conception involves the suppression of the opposite pole of the compromise. The dominant values of design could be seen to have flip-flopped back and forth while ignoring the assumptions that underpin this perspective. In this way, the professional field of design appears to be caught in a perpetual cultural tug-of-war between rationalism and expressionism (Storkerson, 1997). Nevertheless, recent postmodern reappraisals have laid new theoretical foundations for design after the collapse of faith in functionalism (Michl, 2004).

The most characteristic tenet of Postmodernism is that the fundamental truths of European Philosophy and Science (ontology, epistemology, metaphysics, and logic) are in fact contingent, historically specific cultural constructions. Also

[36] Published in English in 1913 as "The evolution of culture marches with the elimination of ornament from useful objects".

[37] This term 'good design' derives from an annual exhibition of contemporary design trends mounted by The Museum of Modern Art (MoMA) in New York between the 1940s and the 1950s. The term was actually used pejoratively by art critic Clement Greenberg to pour scorn on the new art form of Minimalism (Greenberg, 1993): "In 1967, art critic Clement Greenberg attacked the new minimalist art, saying that it was "closer to furniture than art" and comparing it, with an audible sneer, to "good design" executed by someone else rather than made by the artist's own hand." (Poynor, 2005).

these have often served the covert function of empowering members of a dominant social group at the expense of everyone else (Lemke, Undated). The roots of this can be found in the philosophy of the Enlightenment. This argued the world should be understood through individual reasoning, not by accepting unthinkingly the beliefs and agendas of accepted authorities - such as the politics of race, gender, and economics (Sengers, Boehner, David and Kaye, 2005). Postmodernism indicates discontinuities with the ideologies of a singular, progressive, cultural trajectory as espoused in Modernism (Jameson, 1991, p.6-16). This can be attributed to the conditions which result from the unique features of late 20th and early 21st Century life: globalisation, consumerism, the fragmentation of authority, and the commoditisation of knowledge in an 'information economy' (Bell, 1973). Radical eclecticism (Jencks, 1987), a willingness to integrate diverse ideologies, suspicion of 'Grand Narratives' (Lyotard, 1984) (i.e. God, Truth, Justice, Nation, Ideology or Subject) and an emphasis on deconstructing language systems and meta-narratives are some of the characteristic traits of Postmodernism.

A further implication of Postmodernism is that it overturns the validity of an effective 'avant-garde' since there is no single dominant cultural trend to be in advance of (Bürger, 1984, p.63). This idea of an 'avant-garde' runs throughout Modernism up to the 1960s and 1970s. These artists not only attempted to challenge their own practice but also to transform the wider conception of artistic practice, the site of art's production, and the politics of its consumption. However, the notion of an avant-garde which pushes at known boundaries of acceptable art with revolutionary, cultural, or political implications seems quaint in the age of Postmodernism. To claim to be 'avant-garde' in artistic terms in the 21st Century appears naïve.

Nevertheless, Marcus Fairs (2006) latest book 'Twenty-First Century Design: new design icons, from mass market to avant-garde' appropriates this term for use towards current developments in design. Similarly, Lesley Jackson (2004) also uses the term about 'avant-garde' craft practitioners such as Marcel Wanders, Hella Jongerius (Figure 23) and Gijs Bakker.

Figure 23: 'Pushed Washtub', 1996. Hella Jongerius

However, rather than a loss of cultural 'depth' as has been suggested (Gablik, 1985) it has been argued (Azuma, 2001) that in Postmodernism we are replacing the 'Grand Narrative' with the 'Grand Database'. Postmodern works are created not by a sense of authorship or an ideology, but by deconstructing and reconstructing the content of this database by rereading it in a different way. Jean Baudrillard, argues the Modernist distinction between the original and the copy, the real and the image is a redundant notion and that everything becomes a simulacrum in the postmodern era (Baudrillard, 1994). The ability to do this is enhanced with the proliferation of digital technologies.

2.9.4 New forms of design practice

The transformations underway in contemporary design practice are too vast a subject to be dealt with adequately within the scope of this research. There follows a discussion of some of the more significant developments which may help to frame some of the implications for hybrid art and design practice.

The design of everyday objects is increasingly concerned with culture and the communication of the meaning of a product or its use (Norman, 2004). In this way, 'form follows function' might be seen to have been eclipsed by consumer desires for attractiveness and the emotional qualities of objects (Norman, 2004). Krippendorff (1995) argues that artifacts by themselves have no stable meanings and called on the profession of design to concern itself with the meanings artifacts can acquire by their users. He stated that design has become language-like and its objects are 'texts' and that people act not on physical qualities but on what they come to mean to them (Krippendorff, 1995). Krippendorff also specified a need for a new kind of designer. She or he has

highly developed collaborative skills, is aware of second-order understanding[38] and acknowledges that meanings are different in different social settings, in different cultures and at different times. This new designer also makes her or his contributions freely available. Vihma (2002) criticises Krippendorff's use of the term 'meaning'. She states that it is important for him to account how he conceives of meaning and points out that he does not do this. Vihma (2002) asserts that artifacts afford meanings which are not located outside the object or the perceiver but are to be found in their relationship to one another.

Cardoso (2004) argues the 20th Century's understanding of design was structured around a dichotomy of examining the context in which significant objects were produced and received and not that they might possess some sort of inherent formal value. He contends that in the latter decades of the 20th Century designers were only able to escape from the hegemony of the International Style by denying that forms are strictly reducible to predetermined meanings. Cardoso goes on to further undermine functionalism by stating that if the purpose of design was to perfect universal forms, then nearly every object would eventually reach near perfection through the application of strict ergonomic standards and testing. He suggests there are two mechanisms for investing artifacts with meaning – attribution and appropriation. These correspond to different phases in the object's life cycle: production/distribution and consumption/use.

Contemporary design therefore can be said to pay more attention to the relationship between objects and their users beyond only those aspects that are purely ergonomic or functional. This is especially the case with several subdistinctions of design that have emerged in recent years. 'User-centred design' (UCD) is a design philosophy and a multistage problem solving process that not only requires designers to analyse and foresee how users are likely to use a product, but to test the validity of their assumptions about user behaviour in real world tests with actual users. Variations include: cooperative design, participatory design and contextual design. The emerging discipline of

[38] "Designers must begin from their understanding of users' understanding - which he describes as understanding of understanding or second-order understanding. This second-order understanding requires designers to embrace humility and relinquish some control to other stakeholders such as the end-user." (Krippendorff, 1995)

‘experience design’ requires a cross-disciplinary perspective that considers multiple aspects of designing products, processes, services, events, and environments based on the consideration of an individual's or group's needs, desires, beliefs, knowledge, skills, experiences, and perceptions.

Jonathan Chapman’s ‘Emotionally Durable Design: Objects, Experiences and Empathy’ (2005) explores the essential question, why do users discard products that still work? Chapman states that this form of waste represents

> “…a failed user/object relationship, where insufficient empathy led to the perfunctory dumping of one by the other.” (Chapman, 2005, p.20)

Chapman states the inability for products to mutually evolve with their users makes most incapable of sustaining a durable relationship. ‘Emotionally Durable Design’ aims to address the cause of this rather than the symptoms. Chapman claims that approaches to sustainable design such as recycling, biodegradability and design for disassembly only address the symptoms.

> “Users must therefore be designed into narratives as co-producers and not simply as inert, passive witnesses.” (Chapman, 2005, p.128)

These concerns are in common with developments in Human–computer interaction (HCI), and the emergent discipline of interaction design. Again, the scope of this is too extensive to be dealt with adequately within this research. However, it is interesting to note the parallels between these interdisciplinary developments that more fully integrate users in the design process and similar concerns of interactive computer-based artworks.

2.9.5 Implications for audiences and users

Echoing Duchamp (in his speech at the Museum of Modern Art, 1961) Penny (1996) noted the techniques of the observer are as important as the techniques of the artist in establishing meaning in an artwork. If this meaning is founded on the relationship of the audience and the work, then the design of interactive experiences is a further dimension (beyond the 3 main physical dimensions) of designed objects. Penny stated that this was without precedent in the visual and

plastic arts. However, media theorist Lev Manovich argued that all works of art can be described as interactive, because there always has been a feedback condition between the art object and its audience. Manovich maintained that Classical and Modern art were already interactive in that they prompted a viewer to fill in missing information as well as to move his or her body in the reception of the work. (Manovich, 1996). Rammert (1999) speculated on the impossibility of reducing an artifact to one general function or meaning. He stated that technology has no existence outside its use. It is use-relations (which he designates 'interobjectivity') that reveal both the object as a tool and the action of the user as 'technical practice' (Flusser, 1991). Rammert states that this relationship of 'interobjectivity' has to be established between human bodies, physical matter, and symbolic signs to constitute a technology:

> "A machine without someone who controls it is no machine, but an exhibit in a museum or junk in the scrap-yard". (Rammert, 1999).

Graham (1997) examined interactive computer-based artworks specifically looking at the relationship to their audience in conventional gallery settings. Several existing taxonomies of interactivity within art were referenced in this study. These included Bell (1991), Krueger (1983), Malina (1988), Cornock and Edmonds (1973, 1977) and Ascott (1967). Graham summarised these latter classifications in a diagram depicting levels of more or less interactivity. Cornock and Edmonds' taxonomy subdivides art systems into the following categorisations: dynamic, reciprocal, participatory and interactive. Graham extended this taxonomy using a metaphor of 'conversation'. Candy and Edmonds (2002) updated these categories that characterise the relationship between the artwork, artist, viewer and environment: static, dynamic-passive, dynamic-interactive and dynamic-interactive (varying).

More recently, Chapman (2005) has stated:

> "...we do not consume matter, we engage with it, nor do we consume a world of information, we relate to it." (Chapman, 2005, p.149)

This brief review identifies there are implications for the audiences/users that engage new types of computer-designed and/or fabricated objects which draw

on the critical discourse of intersecting disciplinary domains and new cultural contexts. It also indicates the benefit of a cross-disciplinary discourse around this area that can draw on parallel developments from other more mature domains of knowledge.

2.9.6 Re-examining the relationship between art and design

In 1987 Dan Graham and Fruitmarket Gallery, Edinburgh published for the first time the text 'Art as Design/Design as Art' to coincide with the exhibition (27 June — 26 July) of Graham's work 'Interior Design for Space Showing Videotapes (1986)'. The text is constructed, as a collage of quotations, revisions of Dan Graham's earlier texts and new sections referencing sources of inspiration and precursors for Graham's work and the role design played in these. It includes the work of: Claes Oldenburg, Dan Flavin, Robert Venturi, Andy Warhol, John Chamberlain and John Knight. The text explores how the work of these practitioners was specifically designed to foreground the context of the gallery and the conditions within which the work would be received by its audience. In particular, how arrangements of furniture become a stage set for social exchange among visitors to the space. Another issue highlighted is that Pop and Minimal art's relationship to quasi-functional (or non-functional) objects.

'Design≠Art: Functional Objects from Donald Judd to Rachel Whiteread' was an exhibition of the work of 18 artists from the late 1960s to the present, curated by Barbara Bloemink at the Smithsonian Cooper-Hewitt National Design Museum, (September 10, 2004 - 27 February, 2005). Bloemink states in the exhibition catalogue:

> "The separation of 'fine' art from design is a fairly recent Western conceit, and has only been considered an issue during certain eras. So too is the idea, still prevalent, that art is "non-functional." Throughout Western history, art has functioned as religious, ideological, and political propaganda, economic currency, commodity, decoration, and as a vehicle for personal self-aggrandizement. (Bloemink, 2005, p.18)

The exhibition explored the artwork and functional objects produced by Minimalist and Post-minimalist artists. Bloemink, indicates Dadaism, De Stijl and Russian Constructivism as antecedents of this activity. This exhibition only

explores the work of artists[39] acting as designers and does not consider the reciprocal view of designers making works of art.

Conversely, in the paper 'Art in the Context of Design/Design in the Context of Art' - Troels Degn Johansson (2006) sets out to examine the practices of artists and designers reciprocally operating across this disciplinary distinction. Johansson makes use of the Copenhagen-based art collective Superflex and points to their nomination for a design award for their development of a soft drink brand (Guaraná Power!) as an example of art in the context of design. This project was supposed to grow an alternative market for guarana bean farmers in the central Amazon region after a drinks producer made prices on guarana beans crash because of their monopoly of the market. Johansson points to the project 'The Directorate' by another Copenhagen-based group RACA as an example of design in the context of art. This project involved green pillows (two hundred produced by RACA) marked with a logo (that resembled The City of Copenhagen's municipal logo) being placed on public benches by the designers dressed as municipal workers. These benches were cleaned and stolen pillows replaced twice a day for a fortnight.

Johansson asks why artists, designers, critics and theorists maintain, develop, or reject the traditional distinctions between art and design. He indicates a reoccurrence of avant-garde tactics among artists emerging the mid-1990s onwards and cites Nicolas Bourriaud's 'Relational Aesthetics' (coined in 1996) as a means of understanding the work produced by artists and designers whose work is concerned with political and social matters.

> "Relational aesthetics is a theory of aesthetics in which artworks are judged based upon the inter-human relations which they represent, produce, or prompt." (Bourriaud, 2002, p.112)

Johansson refers to this ethos as the 'relational avant-garde'. He indicates the

[39] Richard Artschwager, Barbara Bloom, Scott Burton, John Chamberlain, Ian Hamilton Finlay, Dan Flavin, Bryan Hunt, Donald Judd, Sol Lewitt, Jorge Pardo, Tom Sachs, Joel Shapiro, Rosemarie Trockel, James Turrell, Richard Tuttle, Franz West, Rachel Whiteread and Robert Wilson.

> "...so-called avant-garde strategies operating in art and design today should be seen in a context of '*post-avant-garde*', in which it is no longer relevant to distinguish between the two..." (Johansson, 2006).

The examples cited in this paper concern works by both artists and designers. However, Johansson concedes the activities are so similar that the socio-political subject matter of the projects should be seen as significantly more important than the question of whether the activity is 'art' or 'design'.

Alex Coles' 'DesignArt' (2005) explores the designerly practice of artists over the past century through four areas: pattern, interiors, furniture and architecture. Coles takes great care to point out that 'design art' is a term derived from the contemporary artists he associates with it – his contribution being to push these terms even closer to form 'DesignArt'. Particularly, Joe Scanlan, who defines it thus:

> "Design art could be defined loosely as any artwork that attempts to play with the place, function, and style of art by commingling it with architecture, furniture, and graphic design." (Coles, 2005, p.14)

Coles starting point is the work of Henri Matisse but it is in the paintings and textiles of Sonia Delaunay that he finds the major themes of this work. These are 'simultaneity' (Coles, 2005, p.14) – the flexibility of practitioners to work as both designers and artists at different times; and a high level of value for decoration and ornamentation in the work produced (Coles, 2005, p.139). Coles focuses on artists that are influenced by or have worked as designers rather than designers themselves. In this sense, 'DesignArt' is similar to Bloemink's 'Design≠Art' in that it is not a reciprocal term. Coles identifies some purposes that artists have for design:

> "...to achieve a more rigorous composition; to play disciplines off one another in a creative show-down; to gain control over the various elements that represent them... or to produce a new speculative type of work truly somewhere in-between art and design." (Coles, 2005, p.15)

Unfortunately, Coles leaves the ontological privilege of art intact and renders design as a repository from which to reinvigorate the conventional cultural hierarchy. Nevertheless, there is a suggestion of potential models for

relationships for hybrid art and design in a rereading of this work. What Coles calls 'simultaneous' is more clearly 'contingent' in nature. This type of hybrid practice is context-based where the practitioner operates either as an artist or as a designer at any given time in the manner of Delaunay and Pae White (Coles, 2005, p.137). The next type would be 'dialogistic' - this type of hybrid is highly theoretical or political (Coles, 2005, p.35) and works in-between disciplines in a highly reflexive or critical manner commenting on one domain from another such as Coles' examples of Varvara Stepanova and Andrea Zittel (Coles, 2005, p.39). Coles defines a third type which denies any relationship between domains - this points to the work of Post-painterly Abstract Expressionism and Op Art (Coles, 2005, p.41) as examples of a means of deflecting accusations of decoration for the work of these abstract painters. This seems like a critical dodge. What seems more appropriate particularly in light of the aim of the present study would be a genuinely simultaneous 'hybrid' model of practice that produced a new speculative type of work that is both art and/or design.

At the time of writing, Alex Coles has just edited and published a volume titled 'Design and Art' (2007) in which he backs away from the term 'DesignArt' and states it should now be discarded. Coles puts this down to the fact that the term has been hijacked as a marketing tool by 'glossy lifestyle magazines' (Coles, 2007, p.11). Coles is also critical of Design≠Art which he describes as 'arty-looking design or designer-art' (Coles, 2007, p.11). However, one of the most striking contributions is from Miwon Kwon in an essay first published in this volume. Kwon is writing about the work of Jorge Pardo and states

> "... any art that touts interdisciplinarity or 'crosses boundaries' is attributed with automatic and unquestioned critical value. But it seems to me that even while the disciplinary debates/fights continue in certain sectors of academia, the destabilized state of medium specificity and disciplinary categories is already the dominant or given condition of cultural practice. As such, rather than serving an interventionary function within exclusive art institutions, so-called cross disciplinary practices or events that blur categorical distinctions may simply be symptoms of the tendency towards de-differentiation that pervades cultural experience generally." (Kwon, 2002, p.80).

This idea of a tendency towards de-differentiation reinforces the characteristic traits of Postmodernism (see section 2.9.3). It is refreshing to have this

acknowledged as typical of the contemporary period rather than being part of some self-consciously activist attempt to create a critical position for hybrid art and design practice. This indicates that cross-disciplinary fields of enquiry which provide alternate or parallel standards to the dominant values of established disciplinary discourses need not be founded on a dichotomous or oppositional centre-margin relationship with the 'mainstream'. In this sense a synthetic or pluralist perspective that generates a new sense of disciplinary boundary shifting is merely indicative of an expanded cultural field rather than an assault on disciplinary conventions.

2.9.7 Other hybrid forms of art and design practice

This is a brief review of other developments that indicate further examples of possible hybrid practices that exist in the 'terrain vague' between these domains. 'Terrain vague' is a term used to describe ambiguous, unresolved, and marginalised spaces in the urban landscape - such as industrial wastelands and monotonous suburban developments (Solà-Morales Rubió, 1995). This term is used here to refer to practices that fall between the mainstream discourses of architecture, art, craft and design.

'Critical design' is an alternative approach to established design discourse that results in objects which afford critical reflection on and expose assumptions of design practices. Critical design[40] as defined by Anthony Dunne and Fiona Raby is more of an attitude than a position or method (Dunne and Raby, 2007) which makes use of designed objects as a form of material commentary on consumer culture. The aim of critical design is to provoke reflection on cultural values. This can involve the process of design, the actual object produced and the reception by an audience of such an object. By this means critical designers will often challenge expectations and preconceptions causing new ways of thinking about objects, how we use them, and how they might effect the environment. Critical design

> "...explores a space between fine art and design, showing how designers can use fine-art means - provoking, making ambiguous, making strange..." (Gillian Crampton Smith in Dunne, 1999. p.7)

[40] First used in Anthony Dunne's book Hertzian Tales (1999).

to reimagine the cultural role of designed objects. Critical designs may be fully realised and functioning or might be an 'appearance model' or 'mock-up' - a physical version of a product rendering that might act as a form of speculative design. The concepts or ideas behind the object might be more important than the aesthetic or material concerns of the work in the same way as in conceptual art.

In Hertzian Tales (1999) Dunne argues that consumer electronics embody the cultural ideologies that produce them. The purpose of this work is to relocate

> "...the electronic product beyond a culture of relentless innovation for its own sake, based simply on what is technologically possible and semiologically consumable, to a broader context of critical thinking about its aesthetic role in everyday life." (Dunne, 1999, back cover)

In Design Noir (2001) Dunne & Raby develop this idea further, categorising the ideological nature of design as either 'affirmative' or 'critical' depending on whether it reinforces or challenges the dominant discourse. Dunne and Raby are adamant they are not artists and are not making art (Wiltshire, 2005, p.77).

> "It is definitely not art. It might borrow heavily from art in terms of methods and approaches but that's it. We expect art to be shocking and extreme. Critical Design needs to be closer to the everyday, that's where its power to disturb comes from." (Dunne and Raby, 2007)

Critical design focuses on ideas rather the development of mass-market products. The usual constraints of practicality and function are not applicable and critical designers are liberated to pursue their self-chosen goals rather than those of a client. The work that is shown is often prototypes and is communicated via publication. Dunne states

> "If the design model was viewed as a medium in its own right, it could exploit its nonworking status to address issues beyond the scope of the technically functional prototype. But to achieve this it needs to be considered as a model in the same sense as a mathematical or cognitive model. This enlarged view of the model is already accepted in architecture and fine art..." (Dunne, 1999, p.71)

There are several variations of critical design. The most prominent of these variations are: 'Post-Optimal Design' (Powell, 2005), 'Speculative Design' (Martin and Gaver, 2000), 'Parafunctional Design' (Moreno, 2005) and 'Dissident Design' (Badke and Walker, 2005, p.291). Most of these are similar in intent and output and some of the terms for these are derived from Dunne[41]. Sengers, Boehner, David and Kaye (2005) set out in their paper 'Reflective Design' an argument for a critical design-like approach within HCI research based on the 'critical technical practice' of Agre (1997) to expose the unconscious adoption of values within conventionalised technological research methods.

The 'Device Art' project launched in 2004 and is supported by a five-year grant from the Japan Science and Technology Agency. 'Device Art' is a concept for re-examining the relationships between art, science and technology developed by Machiko Kusahara. Device art is a form of media art that integrates art and technology as well as design, entertainment, and popular culture targeted at audiences beyond galleries or museums through mass production and commercial distribution. Kusahara (2006) in a poster session on 'Device Art' as a developing trend of hardware and object-based media art at ISEA 2006 (Inter-Society for the Electronic Arts) cites early 20th Century avant-garde art movements such as Dada and Surrealism as precursors.

This project seeks to theoretically frame and develop a working model for producing, exhibiting, and distributing 'Device Art' works. These contemplative, functional and interactive objects are hybrids of products, toys, and sculpture.

> "...perhaps the most powerful factor in its emergence is this new relationship to audience. With Device Art, the viewer is engaged with this work in a completely different context. As commercially viable projects, they can be produced in quantity and easily purchased. In fact, the term "viewer" is fundamentally inappropriate, as Device Art will ideally engage its audience through physical interactions with buttons,

[41] e.g. 'Post-Optimal Design' and 'Parafunctional Design'.

knobs, materials and mechanisms - in their own living rooms, kitchens and offices." (Diana, 2007)

Project participants include: Hiroo Iwata (Tsukuba University, researcher in engineering), Kazuhiko Hachiya (artist), Masahiko Inami (University of Electro-Communication, researcher in engineering), Sachiko Kodama (University of Electro-Communication, artist), Ryota Kuwakubo (artist), Taro Maeda (NTT Research Laboratories, researcher in engineering), Nobunichi Tosa (Maywa Denki, artist), Hiroaki Yano (Tsukuba University, researcher in engineering).

Ars Electronica is an organisation based in Linz, Austria, founded in 1979 around a festival for art, technology and society. Since 1986 this has become an annual event. In 1987, the organisation began hosting the Prix Ars Electronica. This event is the Oscars of the media art world. The Prix Ars Electronica calls for entries and awards prizes in the following seven categories:

- Computer Animation – Film – Visual Effects
- Interactive Art
- Digital Musics
- Digital Communities
- u19 – freestyle computing
- [the next idea] Grant
- Media.Art.Research Award

The title and theme of Ars Electronica, 2005 was 'Hybrid: Living in Paradox'. It examined what the organisers deemed the most characteristic condition of our time – hybridity.

> "Digital media art itself is a hybrid born from the connection of art and technology, accumulating diverse modes of expression and demanding a unique crossover of expertise and knowledge." (Stocker and Schöpf, 2005).

The call for the Prix Ars Electronica, 2007 has added a new category:

> "The new 'Hybrid Art' category is dedicated specifically to today's hybrid and transdisciplinary projects and approaches to media art. Primary emphasis is on the process of fusing different media and genres into new

> forms of artistic expression as well as the act of transcending the boundaries between art and research, art and social/political activism, art and pop culture. Jurors will be looking very closely at how dynamically the submitted work defies classification in a single one of the Prix categories of long standing." (Ars Electronica Linz Gmbh, 2007b).

This is another indicator the incidence of border-crossing is on the increase. Practitioners can use computer-based technologies to transcend traditional modes of practice in favour of engaging with what can be viewed as an expanded cultural field. The result of this is the creation of new orders of critical, cultural and technological objects.

2.10 Summary of critical and contextual review

This contextual review was conducted to illuminate the current use of computer-based design and fabrication tools across art and design disciplines. It appears that expanded access to these technologies has come about by the ability of software applications that compile programming code from visual representations of objects (Callicott, 2001). However, only with the increased democratisation and proliferation of computing technologies in the 1990s has there been a truly mass uptake of these tools. Computer-based technologies have become more affordable as the number of their users has increased. Competition between technology providers for this increased volume of users has more recently brought about the condition where smaller companies and even individuals can afford these sophisticated, computer-based design tools.

Many objects that have resulted from the initial use of these technologies by practitioners have been preoccupied with the technical aspects of these digital tools (Bunnell, 1998 and Paul, 1999). There have been a number of exhibitions that have showcased and promoted 'digital sculpture'. However, much of this work imitates the formal strategies of traditional sculpture and the critical discourse around this activity has focused primarily on aspects of productivity. Nevertheless, we have also seen the use of these tools in ways that question notions of originality, uniqueness and authorship and that addresses the scope of both digital manufacturing and the arts.

From the contextual review we can see that computer-based tools have been adopted by diverse practitioners from across the entire range of art and design disciplines. Some of these practitioners are now focusing on exploiting the unique features of the technologies. This is resulting in new means of manufacturing and the development of new skills sets and design methodologies. Malcolm McCullough's 'Abstracting Craft' (1996) was identified by many authors as the principle text of the initial exploration of the relationship between the use of digital technologies and traditional making. McCullough indicates a need for new mental models for understanding objects and processes and calls for more sophisticated and complex ideas and critical frameworks around the use of these technologies. However, not much has been offered in terms of defining what these might be.

The review also considered ways that use of these tools affects the thought processes of practitioners (Harrod, 2002). A distinction was acknowledged between 'pre-digital' and 'digital' practice (Gwilt, 2006). Some practitioners have been exploring innovative design processes such as the use of (generative) software that can evolve structures and objects based on predetermined rules, conditions and variables. This has resulted in nonstandard production processes. Computer-based design and fabrication tools allow for mass-market goods and services to be made specific, to meet an individual customer's requirements. Under particular circumstances these technologies can invert the conventional sequence of product development and manufacturing. As the use of computer-based design and fabrication tools have become more widespread, this points to a more distributed model of digital production that more readily affords small scale manufacturing and customised manufacture.

New production paradigms have brought producers and consumers into a closer relationship that has challenged conventional models of authorship as well as existing industrial and pedagogic models. Across the Internet, user innovation communities are developing around the appropriation and sharing of user-generated content and knowledge (Von Hippel, 2005). It has been speculated that 3D printing will eventually allow a mass audience to manufacture physical items at home. This introduces a reversal of the dominant model of production that has been in place since the industrial revolution (Gershenfeld, 2005). It

has been argued that objects have no stable meanings other than those they get from their users (Krippendorff, 1995). Therefore, these developments collectively reframe the relationship between objects, their makers and their audiences throughout a designed object's life cycle - at conception, production and during their consumption. A systematic means of identifying where in this cycle computer-based design and fabrication tools impact on this process would perhaps make a significant contribution to a greater understanding of objects produced across subject domains.

Practitioners have been making objects that exploit the unique capabilities of computer-based design and fabrication tools and this presents an opportunity to reframe the activities, methods and knowledge of the makers that produced them. Contemporary designers are paying more attention to the relationship between objects and their users beyond only those aspects that are purely ergonomic or functional. In this way designed objects can provide a commentary on consumer culture that provokes reflection on cultural values (Dunne, 1999) or that integrate art, technology, design, entertainment, and popular culture (Kusahara, 2006). These practitioners are engaging with new sets of technologically driven, creative, cultural and economic conditions. There are increasing examples of practitioners that are looking beyond standard means of production to what has been termed 'post-optimal design' that explores the deeper metaphysical dimensions of objects and experiences (Chapman, 2005). These practitioners are not only challenging their own practice but also offering a more extensive conception of production and the politics consumption.

Computer-based design and fabrication tools have rapidly become ubiquitous in contemporary architectural practice and the discourse around these tools is more developed in architecture than in other disciplines. However, contemporary architectural practitioners that make use of new scientific developments in artificial intelligence and evolutionary computation have been criticised from within their own discipline for making use of ideas and processes borrowed from nonarchitectural disciplines (Gwilt, 2006). The ability to generate construction information directly from design information has fundamentally changed the production of buildings. The computer is being

used by architects (and others) as a design tool but also to make 'fabricated buildings' and reflexive structures that evolve and respond intelligently to their particular users and surroundings. As networked technologies become embedded into objects the physical world is gaining digital qualities and the environment is becoming able to respond directly to what 'it' senses. Objects are becoming self-identifying, location-aware and self-documenting (Sterling, 2005). Art and design practitioners are beginning to create '4dspaces' or 'responsive environments' (Bullivant, 2005 and 2006) that make use of sensors and various other digital technologies and are designing the means by which we interact with them.

Digital design and fabrication technologies are fundamentally interdisciplinary and are radically changing how objects are conceived, designed and produced by designer-makers from across art and design disciplines. Digital information can be used for multiple purposes and this can ultimately lead to the breakdown of boundaries between disciplines and the ability to produce objects that are 'otherwise unobtainable' (Harrod, 2002). This indicates an increased fluidity between disciplines and the possibility for new models of disciplinary practice to exist alongside traditional models. This development is significant as it suggests expanded opportunities for practitioners and the possibility of a 3D digital praxis which draws on the critical discourse of intersecting disciplinary domains.

In the context of the use of computer-based design and fabrication tools the definitions that separate artistic practice and design practice are becoming increasingly difficult to characterise. The work being done by practitioners that crosses these conventional disciplines might represent an expanded cultural discourse. The reciprocal nature of this discourse between disciplines is more important than the question of whether the activity is specifically 'art' or 'design'. Coles (2005) has identified types of hybrid art and design practice. These are 'context-based' where the practitioner operates either as an artist or as a designer at any given time; 'dialogistic' where the practitioner works in-between disciplines in a highly reflexive or critical manner commenting on one domain from another. This has led to the conception of a genuinely simultaneous 'hybrid' model of practice that produced a new speculative type of

work that is both art and/or design. The contextual review has indicated there are models of practice that would seem to fit with these distinctions. However, the nature of the relationships between these is not clear.

Gibbons, et al (1994) have stated the basic qualities of contemporary knowledge production are: complexity, hybridity, non-linearity, reflexivity, heterogeneity, and transdisciplinarity. These qualities indicate an increasing de-differentiation of traditional subject domains and these have been identified as symptoms of Postmodernism. These qualities are present in the practices of the art and design practitioners considered in the contextual review. These practitioners can be reframed as a community of interest (CoI) that shares a transdisciplinary design discourse. The objects produced by these practitioners can be considered 'boundary objects' that provide a means of coordination between the various communities of practice that make up this community of interest. These 'boundary objects' draw on developments from across subject domains and contribute to the transdisciplinary design discourse. However, the means by which this integration is brought about is relatively undefined and this indicates a need for a more systematic evaluation of cross-disciplinary work. A starting point in this process would be the development of evaluative criteria that could be applied to computer designed and fabricated objects produced across subject domains.

This research has explored new methods of working and new production ontologies and cultural contexts for computer-designed and/or fabricated objects that exploit computer-based technologies. From the contextual review the researcher has discovered indications of a considerable shift towards forms of art and design practice that indicate hybridity between traditional disciplines. However, there are indications of a need for the development of analytical and evaluative criteria, models of practice and critical language to discuss the relationship between these forms of practice and the objects produced by them. There is also a need for greater understanding of how practitioners engaged in this field are facing the creative possibilities that visual computing offers in challenging the way that art and design practitioners work. The following sections will look at how these gaps in knowledge will be addressed in the context of 'live' professional practice.

3.0 Methodology

This study fits within an exploratory paradigm. The researcher is seeking to find out what is happening - as a snapshot of the field of enquiry - to seek new insights and assess activity from a new perspective. The methodological approach being used in this project can be described as a 'hybrid approach' (Graham, 1997, p.136) that uses multiple sources of evidence. These include:

- the systematic analysis of archived data
- the development of a curatorial framework
- a public exhibition and symposium (resulting from this framework)
- case studies in the form of surveys and interviews with practitioners, audiences and stakeholders
- the development of analytical models to present the findings of the study

The use of several complimentary methods as a means of gathering, corroborating or refuting information has been described as 'triangulation' (Jick, 1979). As far as possible the researcher has attempted to work with two or more sources from different disciplinary perspectives as a means by which to limit bias. However, the researcher has also needed to rely on his own previous experience, the literature and qualitative statements from other professionals to present the evidence. The researcher acknowledges there might be concerns about the objectivity of results that come from this study because of the participatory nature of the researcher's role (e.g. as co-curator of the exhibition) in the study. It is a limitation of this research that the researcher's role in the project might bring accusations of inherent bias or a self-justifying argument. It also has to be accepted that if this research was conducted with another group of practitioners, different results would almost certainly be generated.

Yin (1994) suggests that every investigation should have a general analytic strategy. The current study is an explorative investigation into the work happening across traditional art and design disciplines through the use of common digital tools. This has been done using a cyclic approach, with each cycle involving data collection, interpretation, and a literature search. The research has explored new methods of working and new production ontologies and cultural contexts for computer-designed and/or fabricated objects. The researcher has developed analytical and evaluative criteria, models of practice and critical language for this field of enquiry. This was an iterative process that

started with a theoretical statement[42] that was developed and revised repeatedly. Yin (1994) describes this as 'explanation-building'.

The researcher considered Grounded Theory (GT) (Glaser and Strauss, 1967), as the general research method. GT is based on the finding and labelling of phenomena in a field - discovering theory from data.

> "In discovering theory, one generates conceptual categories or their properties from evidence, then the evidence from which the category emerged is used to illustrate the concept" (Glaser and Strauss, 1967, p.23)

The major strategy used for this is a general method of comparative analysis. Modified GT has recently been cited as a practice-based research method in art and design by Sevaldson (2005, p.179) and Hohl (2007, p.89). However, the researcher realised that although many of the collecting, coding and analysis methods being used in the current study are consistent with GT[43] - because the study spans multiple domains and at least a decade of practice - the exhaustive and prescriptive levels necessary for true GT[44] are impossible in this case.

Yin defines the case study research method as an empirical enquiry that investigates a contemporary phenomenon within its real-life context and in which multiple sources of evidence are used (Yin, 1994, p.23). The researcher recognised the advantages of case studies in creating an understanding of the complex, multidimensional issues arising from the present study. In a qualitative case study the analysis is about making sense of the object of study. The purpose of this study is to explore and evaluate what new types of computer designed and fabricated objects are being created by art and design practitioners. This research project provides an opportunity to critically examine and map this area of enquiry. The evidence gathered through multiple methods has been analysed through categorising and identifying patterns from

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[42] Is a hybrid model of art and design practice emerging out of the use of computer-based tools across traditional disciplinary boundaries?

[43] "The constant comparing of many groups draws the sociologist's attention to their many similarities and differences. Considering these leads him to generate abstract categories and their properties, which, since they emerge from the data, will clearly be important to a theory explaining the kind of behavior under observation" (Glaser and Strauss, 1967, p.36)

[44] "In trying to reach saturation he maximizes differences in his groups in order to maximize the varieties of data bearing on the category, and thereby develops as many diverse properties of the category as possible" (Glaser and Strauss, 1967, p.62)

the data: survey results, interview and symposium transcripts and notes derived from the critical, contextual review. The categories that emerged from coding this material have been related to the critical discourse around the types of objects that are being produced at the current time. In this sense the research is responding to the work that is already being produced and how it is being made.

Because of the large amount of data from multiple sources that this research has generated the researcher has undertaken a systematic organisation of this information in a series of databases[45]. This was important to prevent the researcher from becoming overwhelmed by the data and to prevent losing sight of the original research purpose and questions. These databases have been developed and archived incrementally throughout the period of research. They have been used to categorise, sort, store, and retrieve data for analysis.

3.1 An engaged practitioner

The nature of the PhD project is the research questions and propositions have been identified through practice. The research aims to demonstrate a significant shift in the thinking of practitioners that make use of computer-based tools towards a hybrid model of art and design practice. The researcher is able to conduct this research because of his position as a practitioner and curator in this field. This research is reflexive - it speaks back to practice and to the research participants. It is acknowledged the researcher is engaged, committed and seeking to bring about change in this field of enquiry. The researcher has sought to maintain objectivity by being openly self-questioning and self-critical.

3.1.1 Live discourse

The researcher conducted much research online (particularly of practitioner's websites) and noticed that an increasing amount of weblogs were encountered in Internet searches. Weblogs (or blogs) are web pages that consist of many (usually) short entries organised in reverse chronology (i.e. a reader will see the most recent post first). In 'Democratizing Innovation' Eric von Hippel (2005)

[45] The researcher created a custom FileMaker Pro® databases in order to critically review the archived material from the critical, contextual review. FileMaker Pro® was selected because unlike other commercial database software it easily handles both visual and textual information.

discussed the 'free revealing' of proprietary information and the means by which free revealers can benefit in terms of their professional reputation and network of contacts. Inspired by this, on 1st December, 2005 the researcher launched a research blog[46]. The researcher chose to use Blogger (owned and operated by Google™) because it is set up to work over a web browser and is free (there are many other blogging platforms available).

The researcher has made use of various third-party applications that have been embedded in the blog's sidebar (a column adjacent to the main content of the site) as links and 'widgets'[47]. The researcher has been making use of the web-based news aggregator Bloglines (there are many other aggregators available). This is an application for browsing blogs and other documents via RSS (Really Simple Syndication). RSS is a format to publish frequently updated content such as blog entries in an automated manner. This has allowed the researcher to subscribe to sites that regularly publish information that is pertinent to this research project. These were identified throughout the research process. Within the Bloglines application the researcher can view several 'feeds' (the researcher is currently subscribed to twenty-two separate sources) without having to click on multiple sites.

The researcher has also made use of social book marking web service del.icio.us (there are many other social book marking sites available) for storing, and discovering links added by other users. Users of this service store links to web pages they find useful. These link lists are publicly accessible and other people with similar interests can view the links by categories or keywords. These links can be searched and are ranked by the number of users which have book marked them.

3.2 A critical review of designed objects

The use of computer-based design and fabrication technologies across a range of contexts raises at least one prominent problem that hinders discussion across subject domains. That is how to establish parity between evaluative concepts

[46] http://designedobjects.blogspot.com/

[47] "A web widget is a portable chunk of code that can be installed and executed within any separate HTML-based web page by an end user without requiring additional compilation."
http://en.wikipedia.org/wiki/Web_widget

used for objects of differing scales, functions and purposes? For example, how can we discuss Frank Gehry's Guggenheim Museum in Bilbao, Spain (Figure 24) and Karim Rashid's 'Garbo' rubbish bin (Figure 25) as being of the same order of object? Some may question why we would want to do this in the first place but it is difficult to argue against the fact that neither would have existed had it not been for the use of computer-based design and fabrication tools.

Figure 24: 'Guggenheim Museum Bilbao', 1997. Frank Gehry

The process of analysis began with the most practical course available: analysis of the objects already gathered from the researcher's previous involvement in the field. During the research project, provisional criteria and preliminary models emerged from patterns that were observed. Eventually the data was compacted as it became apparent the computer-based aspects of the conception, production and consumption of the objects formed the core criteria of the study. The study makes use of a set of one hundred and forty-eight objects produced by a wide array of practitioners within the past ten years. This was narrowed from a set of two hundred objects. Fifty-two objects were removed because they were produced by a practitioner already represented in the set (and the objects were of a similar type). Several virtual reality objects were also removed as the study focused in on the production aspects of computer-based design and fabrication technologies in the creation of physical objects.

Figure 25: 'Garbo' polypropylene trash can for Umbra, 1996. Karim Rashid

The aim of this process was to indicate common properties of the objects and identify relationships between 'types' of objects. This involved a process of 'transcoding' (Jameson, 1981, p.40) – the invention and strategic application of a set of terms to analyse and articulate diverse types of objects. This was done to reveal an underlying structure of the field by grouping the objects into classifications. For the basis of this categorisation specific properties and attributes were recorded for each of the objects regardless of the object's source or domain of origin. The researcher experimented with different categorisations to allow different groupings to form. This was repeated many times to redefine the category boundaries and reveal a systematic structure of the field. This was developed to bring consistency to the framework of analysis.

3.3 A survey of international practitioners

The researcher gathered data from a survey of practitioners that use computer-based design and fabrication tools from across the 3D disciplines of art and design. The purpose of this survey was: to develop an understanding of the current use of these technologies in art and design; establish how practitioners think about and engage with these technologies; and generate an understanding of how practitioners relate to and engage with other art and design disciplines. Fifty-seven practitioners were contacted by email and invited to answer fifteen questions - all responses were collected electronically via a web-based application[48]. After collection this data was aggregated so a single practitioner's responses and the collected responses of all practitioners could be viewed and compared.

[48] http://www.surveymonkey.com/

These practitioners represent a spectrum of practices from across disciplines and from a wide range of approaches to their use of computer-based design and fabrication technologies. This includes both emerging practitioners and well-established, exemplary practitioners. At the time of the survey[49] 16 of them (28%) had had previous contact with the researcher. 16 (28%) had no direct previous contact with the researcher but had participated in the artist-led international survey shows from the contextual review (see section 2.3). The remaining 25 practitioners (44%) were selected from the group of cross-disciplinary exemplary practitioners from the contextual review. Of those approached 29 (50.9%) responded. However, 2 practitioners (3.5%) responded by typing random letters into the response fields (spoiled). The total number of responses was therefore 27 (47.4%) of those contacted. 7 practitioners (12.3%) of those invited to contribute to the survey later participated in the 'Perimeters, Boundaries and Borders' exhibition. 4 (7%) of these responded to the survey. At the time they responded to the survey this exhibition had not yet been announced.

An objective of this survey was to establish a baseline of contemporary practice against which to frame the context for the wider study. It was expected that through this means the researcher might gain an opportunity to probe critical language and criteria developed within the field of practice. Coding this data was accomplished both electronically and by hand on printed versions of the survey responses. Categories and patterns were identified and the frequency with which these arose was recorded.

3.4 Development of a curatorial framework

The researcher developed a curatorial framework for a themed exhibition exploring hybrid art and design practice using computer-based design and fabrication tools. The objective for this exhibition was to be the identification of new modes of action and enquiry capable of shaping and qualifying the direction that artists, designers and architects are taking with computer-based technologies. The exhibition was to contain a mixture of existing works (selected from an open call process) and new works (from practitioners selected and invited to participate by the curatorial team in response to the curatorial

[49] 27/02/06 – 24/03/06.

theme/brief). The researcher's aim was to move away from the 'Intersculpt' model - possibly by making partnerships with other organisations. The general idea was to try to 'raise the bar' curatorially and in terms of the quality of the work shown than had been done by the researcher previously and to have a more cohesive exhibition that reflected the creative use of computer-based technologies.

The researcher hoped to gauge response to this research proposition in a live, peer-reviewed context. From the open call for submissions the researcher intended to gain access to professional practitioners and test critical language and criteria. By this means the researcher also aimed to examine the response to the research proposition with funders and project partners and expose the central ideas of this thesis to public scrutiny. The researcher secured support from Arts Council England (ACE), MIRIAD (Manchester Institute for Research and Innovation in Art and Design) and Lancaster City Council to develop an exhibition, symposium and a catalogue (Marshall, 2008). Fast-uk and folly co-presented this exhibition.

The curatorial team consisted of Keith Brown, Cezanne Charles and the researcher for Fast-uk and the Creative Director and Programme Manager of folly. folly is a digital arts organisation committed to enabling new audiences to explore art through technology in Lancashire and Cumbria. Besides being a project partner folly was contracted to undertake the project management of the exhibition. This project management would entail: securing additional project funding as match to the ACE grant; creating an evaluation plan for the exhibition; coordinating publicity and public relations activities; providing administrative support and coordinating volunteers.

The researcher made a presentation to clarify the aims and objectives of the exhibition to the curatorial team. This presentation included a 'wish list' of practitioners the researcher indicated would be appropriate for inclusion in the exhibition. Additional practitioners were suggested by the representatives of folly. The researcher set up a collaborative website (wiki) that was used by the members of the project team. This was used to keep track of information about the selection process for the commissions and the open call. The curatorial

team each selected their top six[50] choices for the commissions. These were collated to produce a shortlist of eight practitioners. These were contacted in turn and invited to propose either a specially commissioned work or a more recent work that had not been shown in the UK previously for the exhibition. Four new works were commissioned from practitioners that were invited to contribute.

Existing works were contributed by ten sets of practitioners. These practitioners responded to the open call for participation that was made publicly available by the Fast-uk and folly websites and was posted on electronic distribution lists and in newsletters and on blogs. The researcher also sent the call to his personal contacts and the respondents of the survey of international practitioners that had previously been conducted. The call was also sent to various university art, architecture and product design departments. Forty-six submissions were received by the due date of the open call. A curatorial meeting was held in Lancaster to select from the open call applications and to review the commission proposals. First the panel viewed the complete documentation submitted by the applicants to gain an overview of the field. Second the panel viewed the documentation again and discussed the merits of the work. At this point each panel member made a decision to consider the individual applicant further or not by a yes or no vote with the majority opinion being considered. If the decision was 'yes' each panel member assigned a score of 3, 2 or 1 (3 being more in favour of the work being included). If the majority opinion was 'no' the application was no longer considered. All applications that were scored were then ranked highest score to lowest. The panel arrived at a shortlist of nine applicants to be considered for support based on the submission's relevance to the exhibition brief, cost, and feasibility. There were several types of work which were similar to each other. In these cases the panel discussed these and arrived at a decision based on which work would contribute to the overall diversity of the exhibition and encourage different types of interaction with the audience.

[50] At that time six commissions had been budgeted.

3.5 A public exhibition and symposium

While there are aspects of this research that can be explored through published material - some of the most important information was likely to emerge in discussion with practitioners. It was intended that through conducting a public exhibition the researcher would: obtain specific qualitative information from a sample of contemporary practitioners; obtain general information relevant to this thesis; and gain insights by making comparisons between qualitative statements made by practitioners.

The researcher secured £30,000 from Arts Council England (ACE) and £5,000 from the Manchester Institute for Research and Innovation in Art and Design (MIRIAD) to develop an exhibition titled 'Perimeters, Boundaries and Borders' (PBB) and a symposium about how computer-based tools are impacting across the 3D art and design disciplines. This exhibition ran from 29th September – 21st October, 2006 in Lancaster. The exhibition venue (CityLab) was a group of historic buildings in the centre of Lancaster that had been newly redeveloped to provide one thousand five hundred square metres of new office space for technology-based start-up businesses.

The exhibition and symposium allowed the researcher to expose the wider public and peers to the research proposition. Case studies were developed around participants in the exhibition to provide an opportunity to capture qualitative statements by surveys and interviews (see section 4.5.4). Visitor's experiences of the exhibition were captured by exit surveys (see section 4.5.5). Interviews were also conducted with the project partners (see section 4.5.6). References to the exhibition in print and online were collected by the researcher (see section 4.5.7). The purpose of collecting these press citations was to note the disciplinary perspectives that regard works to be of interest to see which works that were most discussed and by which disciplinary communities.

A few of the participants[51] in the exhibition were invited to present at a symposium based on the contribution they would potentially make to the discussion, previous experience of presentations they had given and their availability on the day of the symposium. These events allowed the researcher

[51] Tavs Jorgensen Aoife Ludlow, Justin Marshall, Lionel T. Dean and Human Beans.

to survey existing works, explore future trends, gather audience and peer responses and engage the broader community of interest around the field of enquiry.

This symposium brought together artists, designers, architects, craft makers, academics, students and others to talk about the 'Perimeters, Boundaries and Borders' exhibition and discuss how computer-based design and fabrication tools have impacted on creative practice and production methods. The event was held at St. Martin's College in Lancaster on Thursday 28th September, 2006 from 1 – 5pm. This was the same day the exhibition opened and those present were encouraged to go to the opening.

Everyone that attended had been given a pack of information about the schedule of the event, information on the speakers, an exhibition guide, invitations to the opening of the exhibition and an evaluation survey. In addition folly also conducted an equal opportunities monitoring survey that gathered demographic data from attendees. Thirty people attended the symposium. Thirteen people completed the survey. This represents 43% of the total attendance. The attendees were asked how they had first become aware of Fast-uk or folly. They were also asked to indicate the sector they work in. The next two questions were presented as a Likert scale to measure the extent to which the visitor agreed or disagreed with a series of statements. The scale was 1) strongly agree, 2) agree, 3) neither agree or disagree, 4) disagree, 5) strongly disagree and the statements were:

- Today's symposium addressed the issues stated in the promotional materials
- Today's symposium provided valuable insight into the topic

The next three questions were presented as a Likert scale to measure or to rate aspects of the event. The scale was 1) excellent, 2) good, 3) fair, 4) poor, 5) very poor and the aspects were:

- How would you rate the quality of invited keynote speakers/lecturers?
- How would you rate the organisation and management?
- How would you rate the venue?

The survey also asked if the forum was a good mix of presentation and participation (dialogue) and if the event met their expectations? Following from this it asked what the attendees' expectations at the beginning were and to what degree they were met. How did they change? What was overlooked or left out? They were asked about how they first heard about the event and why they decided to attend this event? Also, they were asked if they would be interested in attending similar symposiums and if they had any suggestions or comments. The results of this survey are presented in section 4.5.3.

3.5.1 Practitioner interviews

Six practitioners from across the 3D art and design making disciplines whose work was included in the 'Perimeters, Boundaries and Borders' exhibition were interviewed. The main aim of these interviews was to examine:

- their expectations of the exhibition
- their actual experience of the exhibition
- any impact the exhibition had on their thinking and their practice

The main aim of these interviews was to examine similarities and differences between the practitioners' experiences and to solicit their reflections on the exhibition. These post-exhibition interviews offered an opportunity to capture participant-practitioner's qualitative opinions and allow for issues to be raised that might not be immediately obvious otherwise. The researcher hoped to determine if the participants thought the exhibition was representative of the direction that art and design practitioners are taking in relation to computer-based design and fabrication tools. A further objective of the research was to establish if the practitioners thought a trend towards a hybrid model of art and design practice is emerging out of the use of computer-based design and fabrication technologies.

The researcher's intention was to focus on those practitioners from the exhibition that were most closely concerned with the primary research focus of those working in material practice using computer-based design and fabrication tools. Initially it was an objective to conduct all the interviews in person. Also, it was important to get responses from participants that had visited the exhibition. From this perspective UK-based practitioners were chosen from a purely pragmatic standpoint. Each practitioner was interviewed to reveal how

their experience and perceptions related to their use of technologies and the nature of their practice.

Semi-structured interviews were conducted with the practitioners. The interviews involved the researcher asking the practitioner a list of forty predetermined questions about their experience of the exhibition which was recorded on a digital voice recorder. Each practitioner interviewed understood that their voice would be recorded. A copy of the questions was given to each practitioner before the interview and they had the opportunity to review them and ask any questions. The interviews were conducted in casual settings and the practitioners were encouraged to go off-topic if something occurred to them. However, all the practitioners were asked the same questions by the researcher. Since there was the possibility the relationship with the researcher (as curator and commissioner for the exhibition) might bias their response - the questions asked were constant across all respondents and asked in a standardised order. The interviewer explained aspects of the questions the interviewee did not understand or found confusing but whenever issues of terminology arose the interviewee was asked to respond from their own understanding of the term. Each interview was transcribed by a third-party transcription service, proofed by the researcher and approved by the practitioners. The results of these interviews are presented in section 4.5.4.

3.5.2 Audience survey

An audience survey was conducted during the 'Perimeters, Boundaries and Borders' exhibition. The primary aim of this survey was to gather qualitative statements from members of the public about the exhibition. The researcher developed a set of questions to be put to visitors to the exhibition. This survey was to be delivered by volunteer invigilators that were present in the exhibition space always while the exhibition was open. However, folly had also developed a survey to gather their own feedback. It was decided to combine these two surveys. In addition folly also conducted an equal opportunities monitoring survey that gathered demographic data from attendees of the f.city Festival of Digital Culture.

The survey was carried out between 28/09/2006 and 21/10/2006. Visitors were approached by an invigilator as they left the exhibition and asked to fill in a questionnaire. 28 people completed the survey. This represents 4.7% of the total visitors (593) to the exhibition. This survey consisted of a set of twelve questions on a single side of printed A4 paper on a clipboard. This asked the visitor to indicate the date of their visit, how they had first become aware of Fast-uk or folly and their reason for attending. The next six questions were presented as a Likert scale to measure the extent to which the visitor agreed or disagreed with a series of statements. The scale was 1) strongly agree, 2) agree, 3) neither agree or disagree, 4) disagree, 5) strongly disagree and the statements were:

- The exhibition was easy to find
- The exhibition was informative and interesting
- I found the interactive elements easy and was able to engage with them
- I found the signage and interpretive materials useful and appropriate
- The staff were polite, friendly and helpful
- The staff were knowledgeable

The remaining questions asked what visitors liked most and least about the exhibition and where they had heard about the exhibition. The results of this survey are presented in section 4.5.5.

3.5.3 Partner interviews

The researcher interviewed the representatives of the partnering organisation (folly) that had been involved throughout the management of the project and had participated on the curatorial panel. The Creative Director (CD) was the signatory on the consultant's agreement with Fast-uk and the Programme Manager (PM) acted as Project Manager for the exhibition. Both of these interviews were conducted face-to-face. The main aim of these interviews was to examine:

- folly's expectations of the exhibition
- folly's experience of the exhibition
- any impact the exhibition had on folly

Semi-structured interviews were conducted with the partners. The interviews involved the researcher asking the practitioner a list of thirty predetermined questions about their experience of the exhibition which was recorded on a

digital voice recorder. Each partner interviewed was aware their voice would be recorded. A copy of the questions was given to each practitioner before the interview and they had the opportunity to review them and ask any questions. The interviews were conducted in casual settings and the practitioners were encouraged to go off-topic if something occurred to them. However, both partners were asked the same questions by the researcher in a standardised order. The interviewer explained aspects of the questions the interviewee did not understand or found confusing but whenever issues of terminology arose the interviewee was asked to respond from their own understanding of the term. Each interview was transcribed by a third-party transcription service, proofed by the researcher and approved by the partners. The results of these interviews are presented in section 4.5.6.

3.6 Development of analytical models

This research seeks to critically map how the use of computer-based tools impact on current disciplinary boundaries. The researcher is actively trying to develop critical language by which to better compare diverse objects across disciplines. To draw distinctions between projects across disciplinary boundaries the researcher has been working on proposed models of the relationships between:

- the integration of computer-based technologies and the objects produced by practitioners using them
- various types of cross-disciplinary or hybrid art and design practice

It was intended these would allow the researcher to present the findings of the study and develop the critical language, criteria and framework of analysis to a wider context.

3.6.1 Technology adoption models

As previously stated by Harrod (2002) and Lynn (Lynn and Rashid, 2003) the introduction of new technologies can disrupt and therefore change the way practitioners perform tasks. Since this research is concerned with use of computer-based design and fabrication tools it is important to consider a general theoretical understanding of the adoption of these technologies. Björnsson, Shariq & Taylor (2003) have conducted research at Stanford University into the adoption of new technologies in the architecture,

engineering and construction (AEC) industry. However, this research is focused on innovation and building a predictive model of the AEC industry's technology adoption behaviour. What is needed is a general understanding of the typical patterns (if any) that diverse practitioners go through when integrating these technologies into their practice and whether there is any indication that this might yield a greater integration between cross-disciplinary fields of enquiry.

Any suitable model would not be categorised by time but rather defined for the sophistication with which the technologies were integrated within a given practitioner's practice. Initially the researcher made a distinction between modes as 'passive' and 'active' (Marshall and Pengelly, 2005a). The 'passive' mode was considered to represent the initial exposure of the technologies to practitioners and their mostly superficial use of these. An 'active' approach represented a shift in order of magnitude in the level of engagement and sophistication with their understanding and command of the technology involved. Objects produced in an 'active' mode would be more experimental in nature and would have been made purposely to exploit the technology. However, this dichotomous distinction was considered clumsy and other models were explored.

In 'Pathways to Innovation in Digital Culture' Michael Century (1999) draws on the work of economist Christopher Freeman who distinguishes four categories of innovation and their diffusion: incremental innovations, radical innovations, new technological systems, and changes in techno-economic paradigm. (Freeman, 1992). Incremental innovation involves gradually improving existing technologies or processes. Radical innovations deviate from normal or standard creativity. New technological systems involve the synthesis and combination of innovations of both prior types. Changes in techno-economic paradigms are extensive transformations based on innovations that overturn the existing dominant technology or status quo. The researcher tried to make a system of distinction based on these categories (Marshall and Pengelly 2005b). However, this model was an attempt to place too many disparate qualities into relation with one another and was discarded.

There are many existing technology adoption models which all seem to be focused in very specific fields. Perhaps the most general is the Rogers model (formalised in 1962). Rogers (2003) stated that adopters of any new innovation can be categorised as 'innovators', 'early adopters', 'early majority', 'late majority' and 'laggards' represented as a bell curve. This model is inappropriate since it is based on the passage of time rather than the development of an individual case.

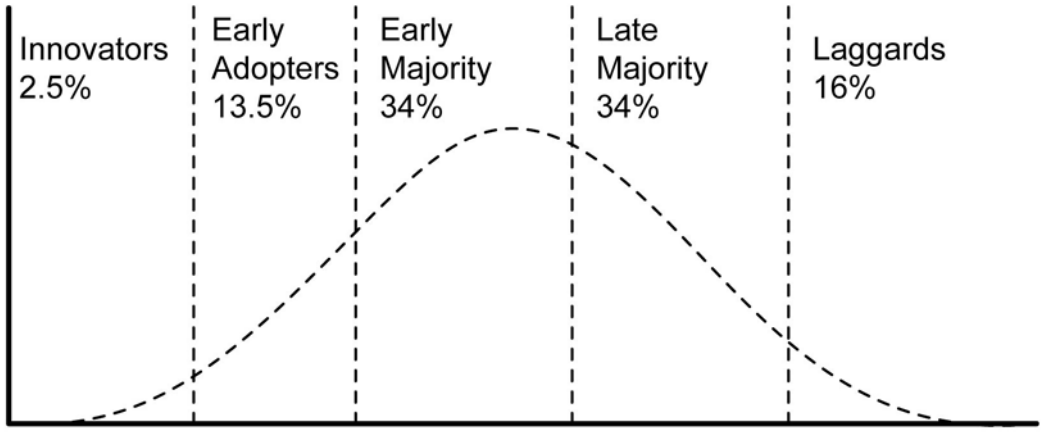

Figure 26: Rogers technology adoption model

The Technology Acceptance Model (Furneaux, 2006) is an information systems theory that models how users come to accept and use a technology (Davis, 1989). Pereira (2002, p.40-49) has proposed an adopter-centred, process-oriented model with which to explore behavioural processes related to technology adoption. These approaches are concerned with adoption as a process and the factors that affect adopters' perceptions and attitudes.

A more appropriate model was found in the Apple Classrooms of Tomorrow (ACOT) project (Apple, 2007). This project involved thirty-two teachers and 650 students in primary and secondary education in the US. The project documented the course of instructional change in those classrooms from 1985 to 1990 when its findings were reported. An aim of the project was to document how learning and teaching change in technology-rich environments, what factors inhibit the changes and what support is needed to effect fundamental and sustainable change.

Entry	"The first weeks of the project at each site were given over to unpacking boxes, running extension cords, inserting cards, formatting disks, checking out home systems - generally trying to establish order in radically transformed physical environments."
Adoption	"Later in the year, teachers' concerns focused on using computers rather than connecting them. They adopted the technology to support familiar methods and materials."
Adaptation	"In this phase, productivity emerged as a major theme. Students produced more faster. Teachers discovered they could cover the standard curriculum in less time with technology, leaving more time for higher order learning and problem solving."
Appropriation	"Appropriation is the point at which an individual comes to understand technology and use it effortlessly as a tool to accomplish real work."
Invention	"The final stage in this model of instructional evolution is really a placeholder for further development by ACOT teachers and for the new learning environments that they will create."

Table 4: The ACOT Model (after Dwyer, Ringstaff, and Sandholtz, 1990)

The ACOT Model (Dwyer, Ringstaff, and Sandholtz, 1990) is an evolutionary model divided into five phases, i.e. Entry, Adoption, Adaptation, Appropriation and Invention (Table 4). As the participants moved through these stages, traditional methods were initially challenged by the introduction of technology and then gradually transformed by increasingly dynamic learning experiences. In the ACOT project these 5 phases were analysed and presented as 3 general stages (Sandholtz, Ringstaff and Dwyer, 1990):

Survival	The introduction of computers introduced a whole new realm of physical and technical problems which led to high levels of disruption.
Mastery	Strategies for dealing with many of the problems of the previous stage had been developed. Technical problems continued but were less disruptive, and were more able to be avoided or at least identified when they occurred. Expertise with the technology was developed resulting in greater confidence.
Impact	Ways to cover regular work faster were developed leaving time for problem solving and higher-level thinking. New ways to optimise the computer's ability to provide immediate feedback were implemented allowing tasks to be individualised. Technology had such an impact that working without it could not be imagined. Although some problems could never be eliminated completely, the benefits significantly outweighed the drawbacks.

Table 5: The ACOT phases presented as 3 general stages (after Sandholtz, Ringstaff and Dwyer, 1990)

The researcher applied (Marshall and Pengelly, 2006) these phase definitions from the project to indicate the critical transitions between integration of computer-based design and fabrication tools by diverse practitioners from across the 3D art and design making disciplines:

- Entry Phase - in which practitioners are learning the basics of the new technologies. Methods of working and outputs remain largely derivative of the canon of conventional disciplinary practice, augmented by superficial experimentation with the new tool set.
- Adoption Phase - the computer technologies are beginning to become integrated with traditional disciplinary practices. Although the methods of working have changed, the outputs remain as an extension of the practitioner's discourse.
- Adaptation Phase - use of computer technologies has become consistent; with productivity and efficiency as the primary contributions made by the technologies. This phase is analogous to the conventional use of the technologies within an industrial context.
- Appropriation Phase - is an extension of the previous three phases in which the practitioner displays a developing command and understanding of the technologies to the point where innovative applications and discontinuities with previous models of practice emerge. At this phase, projects are more likely to engage in a recognisable cross-

disciplinary discourse as new situations beyond single disciplinary paradigms are explored.

- Invention Phase - is deemed less an actual phase than a mind-set, implying willingness to experiment and change. This correlates to our proposition that a new object grammar and a new hybrid domain have been achieved which remains meaningful and understandable to members of the practitioner's discourse community but also to practitioners of other discourses. The resulting artifacts offer counter-propositions and critical technical practice to the main disciplinary discourse through radical innovation of a different order from the Entry Phase.

Entry Phase	Adoption Phase	Adaptation Phase	Appropriation Phase	Invention Phase
> Increasing levels of integration in the use of computer-based tools >				

Table 6: A model of the phases that practitioners go through when integrating computer-based tools into their practice

This model has been used as a method of analysis in the critical review of one hundred and forty-eight designed objects produced by a wide array of practitioners within the past ten years (see section 4.2.1).

3.6.2 Klein group model

To draw distinctions between objects produced across the 3D art and design making disciplines the researcher has been working on models of the relationship between computer-based design and fabrication technologies. The researcher has also been working on modelling forms of practice that show a greater integration between the 3D art and design disciplines. One of the researcher's stated objectives for this research was to develop a contemporary version of Rosalind Krauss's 'Klein group[52]' model from the 1979[53] essay 'Sculpture in the Expanded Field' (Krauss, 1979) that takes into consideration developments in the field from the use of digital technologies.

In this essay Krauss contends that since the Renaissance (particularly since the 1950s) sculpture has become defined as a negative proposition. Sculpture is that which is 'not-architecture' and 'not-landscape'. Krauss sets this out diagrammatically and expands this to include the implicit relationship of these

[52] In mathematics the Klein four-group (or just Klein group), named after Felix Klein, is a group with four elements.
[53] This essay was originally published in October 8 (Spring 1979).

negative terms to their positives ('landscape' and 'architecture') as a set of binary pairs (Figure 27). As well as these five categories Krauss identified three new positions: 'site construction' (the conjunction of 'landscape' and 'architecture'), 'marked sites' (the conjunction of 'landscape' and 'non-landscape') and 'axiomatic structures' (the conjunction of 'architecture' and 'non-architecture').

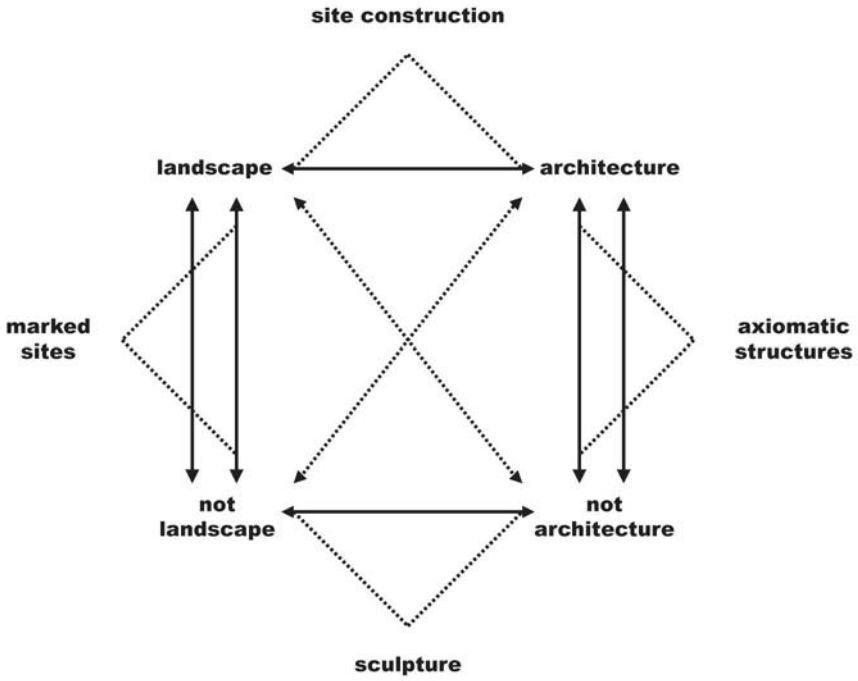

Figure 27: 'Klein group' model from 'Sculpture in the Expanded Field' (Krauss, 1979)

This method is related to the semiotic square. This was introduced by the structuralist semiotician Algirdas Greimas as a means of analysing paired concepts more fully. The semiotic square is intended to map the logical conjunctions and disjunctions relating key features in a text. Starting with a binary opposition the semiotic square is capable of generating possibilities for relationships between categories beyond the 'either/or' of binary logic. Krauss's expanded field is a relationship of categories and their negatives to expand the definition of what sculpture can be. When this essay was first published in 1979 Krauss sought to apply this method to the critical discourse of fine art to the types of artworks that had been produced in the 1960s and 1970s (for example

works by Robert Smithson, Robert Morris, Robert Irwin, Alice Aycock, John Mason, Michael Heizer, Mary Miss and Charles Simonds).

In this sense Krauss was responding to the work that had already been produced and the activities of those making this work. This model simultaneously expands the idea of sculpture and opens it up to be inclusive of other disciplines. Also this model presents a means of understanding the work that was already being made. Krauss states

> "*Sculpture* is rather only one term on the periphery of a field in which there are other, differently structured possibilities. And one has thereby gained the "permission" to think these other forms." (Krauss, 1979, p.38)

More recently Jane Rendell (2006) referenced Krauss's model in discussing the relationship of art and architecture

> "It is important, however, not to use the square as a map that defines a finite set of categories but rather to regard it as a mapping that remains open to the emergence of new possibilities." (Rendell, 2006, p.43)

Rendell continues

> "Today, definitions and categorizations of art are occurring across multiple disciplines rather than within one, requiring new terms and modes of thinking that allow us to identify the particularities and differences of the various related practices in ways that go beyond opposition. To do this I propose that we need to understand artworks as products of specific processes, of production and reception, that operate within a further expanded and interdisciplinary field, where terms are not only defined through one discipline but by many simultaneously." (Rendell, 2006, p.43)

This statement was published two years after the start of the current research project. It neatly summarises the aim of this study. By this method the researcher seeks to visualise the terrain of the field of enquiry.

3.7 Summary of methodology

The critical, contextual review suggested there are types of practice that would fit a 'hybrid' model of art and design practice. However, these are undefined and this indicates a need for a more systematic evaluation of cross-disciplinary

work. The review indicated a need for a means of identifying where computer-based design and fabrication tools impact on the cycles of conception, production and consumption of objects produced across art and design subject domains. This includes a need for the development of analytical and evaluative criteria and critical language to discuss the relationships between 'hybrid' forms of practice and the objects produced by them.

The research comprises a study of diverse practitioners with an established digital practice that makes comparisons and gathers insights into key aspects of their relationships with the tools they use and the objects they create. The aim of this study is to establish a clearer understanding of the use of computer-based tools and evaluate the work happening across traditional disciplines. This study uses multiple sources of evidence. These include:

- a systematic analysis of archived data
- the development of a curatorial framework (and a public exhibition and symposium resulting from this framework)
- surveys and interviews with audiences, practitioners and stakeholders
- the development of models of the adoption of computer-based design and fabrication technologies by practitioners and new models of practice that yield a greater integration between the 3D art and design disciplines (within the context of the researcher's practice)

The research focuses on the work that is being produced by practitioners. This study explores similarities and differences between individuals and is conducted in the context of 'live' professional practice. The research is designed to enable the researcher to draw conclusions broadly about the nature of the relationships between practitioners, disciplines, tools and the types of objects produced. The researcher is seeking to assess current activity in the field of enquiry from a new perspective and within its real-life context. The approach being used can be described as a 'hybrid approach' (Graham, 1997).

4.0 Results

This section presents the outcomes of the application of the methods outlined in the previous section. The researcher felt it was necessary to draw upon this wide range of sources to cover the use of computer-based technologies from multiple disciplinary perspectives and within different contexts. These complimentary methods operate as a means by which to explore the impact of new technologies on methods of working for art and design practitioners.

4.1 An engaged practitioner

Throughout the period of research the researcher has remained active as a practitioner in the field of enquiry. This has enabled the researcher to gain a better understanding of the opportunities and challenges of the context within which this research is located. This study has presented the opportunity for increased professional recognition of the researcher within this wider community through many presentations, publications and affiliations with professional bodies. For example, in 2005 the researcher won first prize in the Stimulate Potential and Release Creativity competition (SPARC) sponsored by New Horizons Professional Development Consultants and The Scottish Institute for Enterprise for an innovative product design website[54]. The researcher was also invited to Chair a session at the 6th International Conference on Computer-Aided Industrial Design & Conceptual Design (CAID&CD 2005) at Delft University of Technology in the Netherlands. He was an invited speaker at the UK product launch of the 3D modelling application Rhinoceros® 4.0 and the researcher's digital 3D design work has been featured as a case study on the UK supplier of this software[55].

In 2007 the researcher was also invited to present and participate in a research symposium 'In the Cross-border of Digital Media and Physical Form' (at the International Ceramic Research Centre, Guldagergaard, Denmark). And was a Roman J. Witt Visiting Artist at The University of Michigan School of Art & Design, Ann Arbor, Michigan. The researcher acted as a consultant and contributed to a film about 3D computer technologies by the global trend

[54] http://www.idware.co.uk/
[55] http://www.simplyrhino.co.uk/industries/artandsculpture.html

service Preview Trend Direction[56]. He is also a member of the advisory group for the 'Multimodal Representation of Urban Space' project (a 'Designing for the 21st Century' research cluster supported by the Engineering and Physical Sciences Research Council and Arts and Humanities Research Council). These activities underpin, locate and have been informed by this research. The aim of this study is to establish a clearer understanding of the use of computer-based tools across subject domains and provide an opportunity to critically examine and map this area of enquiry. This research project has provided a supportive and structured context for the researcher to develop a critical view of theory, research and practice and to identify new kinds of objects and methods of working.

4.1.1 Live discourse

The research blog has been a useful method to disseminate information about the research project and has contributed to increased professional esteem for the researcher. The research blog has been a useful tool to filter and make connections between various information sources. The blog was originally intended as a means of tracking and storing the researcher's online activity throughout the research project (and a method of reporting and reflecting on this). The blog has served as a record of some of the thoughts, arguments and questions of the researcher throughout this period. The frequency with which the researcher has posted to the blog has varied. However, since the researcher was conducting this study at a distance from the host university the blog has served as a portal to a wider community. For readers it operates as an introduction to explain the research and to help define the field of enquiry.

Since launch the site has had 13,520[57] visitors. Because of the interest created by this site the researcher has been contacted by and is now corresponding with other international researchers that would have been otherwise unknown. Through RSS feeds and social book marking the researcher has been able to track developments in the field as they happen and have an indication of the relative importance of that development by the number of references that occur.

[56] http://www.previewtrend.com/

[57] The total number of pages viewed is 23,214. Information from http://www.sitemeter.com/ recorded on 04/09/2007.

This is not a replacement for traditional research methods but it has offered a means of engaging with a live discourse of an international scope.

The researcher has tried to maintain the rigorous and formal citation practice of academic writing in posting to the blog. It was felt that this would be of most benefit to the researcher and academic readers. This allowed the researcher to compile a paper for the International Conference on Engineering and Product Design Education, 2007 from several blog posts (Malins, Pengelly and Marshall, 2007, p.437-441).

4.2 A critical review of designed objects

The use of computer-based design and fabrication technologies across contexts raises at least one prominent problem that hinders discussion across subject domains. That is how to establish parity between evaluative concepts used for objects of differing scales, functions and purposes?

The aim of this process was to create a theoretical picture of the field of study by indicating common properties of the objects examined and by identifying relationships between 'types' of objects. This was done to try to reveal an underlying structure of the field by grouping the objects into classifications. For the basis of this categorisation specific properties and attributes were recorded for each of the objects regardless of the object's source or domain of origin. The researcher experimented with different categorisations to allow different groupings to form. This was repeated many times to redefine the category boundaries and reveal a systematic structure of the field. The current working categories are recorded in the form of a FileMaker Pro® database. This was developed to bring consistency to the framework of analysis. A description of these categories now follows.

4.2.1 Database categories

Descriptive information about each object was recorded. This included one or more images (Image) of the object, the title (Title) of the work and the date (Date) it was produced. The file name of the indicative image was recorded

(Image Source[58]). An indication of the source of the object was also recorded (Code). These include the international survey exhibitions and projects that have showcased and promoted the use of digital production technologies, exemplary practitioners from across disciplines identified through the research and participating practitioners from the 'Perimeters, Boundaries and Borders' exhibition.

Code	Source
CALM	Creating Art with Layer Manufacture
CN	Connectivity
FAST	Fast-uk member archive (from researcher)
IRPSE	International Rapid Prototyping Sculpture Exhibition
IS05	Intersculpt 2005
ISOH	Intersculpt: Ohio 01 (curated by researcher)
ISUK	Intersculpt: UK 2003 (curated by researcher)
MM	Mind into Matter: New Digital Sculpture
PBB	Perimeters, Boundaries and Borders
TDE	Transdisciplinary exemplars
TS	Telesculpture

Table 7: A coded indication of the object's source

The names of the practitioners responsible for the objects were also recorded (Maker) and an indication of their disciplinary background (Discipline). For these one hundred and forty-eight objects these include: architecture, art, art and architecture, art (hybrid), computer science, craft, craft (hybrid), design, design (hybrid), engineering, graphic design, mathematics and printmaking. The address of these practitioners' websites or the exhibition the selected object was shown in was also recorded (Website). Any additional descriptive information about the object was also recorded (Notes).

Two terms that were often made use of by practitioners from the contextual review and the survey conducted were chosen as criteria by which to make critical distinctions about these objects. These are 'complexity' and 'sophistication'. The researcher has attempted to unpack these terms and apply

[58] This category could be specified when the database was imported into the analysis software Omniscope to show the images.

them as a means of categorisation. The practitioners surveyed by the researcher considered that one of the key benefits offered by computer-based design and fabrication technologies was the ability to create objects of a complexity not possible to produce by other means. 'Complexity' would appear to be the result of two (or more) subsequent categories. The first of these is scale. Using the example cited above, clearly Gehry's museum is of a higher order of complexity than Rashid's bucket. Even the museum's plumbing alone is more complex than the risers and waterlines in the injection moulding tool used to produce hundreds of thousands of bins. Therefore, these two objects can only be compared by scale at the point where Gehry's preliminary massing-model is digitised by a laser scanner (see section 2.5). Only on the outer surface or form of an object can comparisons be made across scales. Consequently, the researcher chose not to apply a value to this category. Instead, four descriptive categories were applied by which the relative sizes (Scale) of the objects could be organised. These are: handheld, furniture, vehicle and building – nothing other than the approximate dimensions of the objects are implied by this category.

The second attribute that would appear to contribute to the complexity of an object is its structure. Here more specific determinations can be made. Again, using the example above it is apparent the trash can consists of a single object (Part). The museum is not just a combination of parts (Assembly) but it is a group of interrelated elements comprising a unified whole (System). Values are assigned for the increasing complexity as follows: Part = 1, Assembly = 2 and System = 3. We therefore arrive at a value for the complexity of an object thus: Complexity = Scale (0, descriptive term) + Structure (1-3).

Figure 28: 'Blur Building', 2002. Diller + Scofidio

The instance of Rashid's 'Garbo' bin (above) illustrates an object that is composed of a single part. This is obvious. An example of a system would be Elizabeth Diller and Ricardo Scofidio's 'Blur Building' - a temporary media pavilion for Swiss Expo 2002 erected in Lake Neuchatel in Yverdon-les-Bains, Switzerland (Figure 28). This tensegrity[59] structure of pipes was 91m wide by 61m deep by 23m high. Lake water was sprayed as a fine mist through 31,500 high-pressure mist nozzles giving the structure the appearance of a cloud. The water pressure was regulated by a computer-controlled array of sensors which responded to the conditions of temperature, humidity, wind speed and direction to adjust the nozzles and maintain the cloud's form. This was a complex project that not only housed several media-based installations but also a bar that served mineral waters from around the world. To put this in perspective it is a bit like taking the plumbing out of the Guggenheim Museum (as mentioned above) making it self-supporting and having it generate a water vapour-based point cloud in real time based on the climate of its environment. An example of an object that is an assembly of parts would be Reed Kram and Clemens Weisshaar's 'Breeding Tables' (Figure 29) that was put into production by Moroso under the name 'T-Countach'. The steel frames of these tables were generated by algorithms and are visually reminiscent of the branching that occurs in plant growth. The individual components of the table 'legs' are made by computer-controlled laser cutting and bending machines and exist as a potentially infinite series. However the commercially available versions are only offered in two sizes. The tables have a tempered glass top and are finished by traditional methods.

Figure 29: 'Breeding Tables', 2005. Kram/Weisshaar

[59] Tensegrity is the name for a complementary relationship between compression and tension.

The second term made use of by practitioners that indicates increased conceptual and technical skill applied to the innovative use of computer-based design and fabrication technologies is 'sophistication'. This was unpacked to result in three subcategories of distinction. The first of these assigns a value to the stage in the production cycle (Production Stage - see Table 8) of the objects within which the use of digital design and fabrication tools are integrated into the process. The scope of this category applies to the technological aspects of the conception or design of the objects, the production or fabrication of the objects and the consumption or reception of the objects by users or an audience. The researcher has chosen to add more value for each stage that computer-based technologies are applied within.

Production Stage	Value
Conception	1
Production	1
Consumption	1
Conception & Production	2
Production & Consumption	2
Conception & Consumption	2
Conception & Production & Consumption	3

Table 8: The stage in the production cycle within which the use of digital design and fabrication tools are integrated into the process

Since this study is concerned with objects produced by computer-based design and fabrication technologies, most objects fall into the 'Conception & Production' category by definition. There are exceptions. For example, 'D-tower' (Figure 30) a public art piece by architect Lars Spuybroek and artist Q. S. Serafijn that was commissioned by the city of Doetinchem in the Netherlands. This work maps and displays the emotions of the local community by changing colour in response to surveys conducted of fifty local residents on the internet.

Figure 30: 'D-tower', 2004. Lars Spuybroek/NOX and Q. S. Serafijn

Also the piece 'Blusher' (Figure 31) by architectural collective sixteen*(makers) which is a responsive gallery-based installation that incorporates embedded sensing and actuation technologies that changes its configuration based on the proximity of the audience. Both of these objects were designed by CAD, fabricated using CNC technologies and interact with their viewers by computer-based technologies. Therefore, both these objects have digital design and fabrication technologies integrated at the 'Conception, Production and Consumption' stages.

Figure 31: 'Blusher', 2001. sixteen*(makers)

The next subcategory of the 'sophistication' of an object is the level to which computer-based design and fabrication technologies have been integrated within a given practitioner's practice. To do this the researcher has applied the phasing developed from the Apple Classrooms of Tomorrow (ACOT) project (see section 3.6.1). This model is an evolutionary model divided into five phases, i.e. Entry, Adoption, Adaptation, Appropriation and Invention. Traditional methods are initially challenged by the introduction of technology and then gradually transformed by it. In early versions of the application of this model to the objects in the data set the researcher found that often determining

which side of a category distinction an object was on was subject to issues of personal taste or prejudice. In the ACOT project the five phases were analysed and presented as 3 general stages: survival, mastery and impact (see Table 9). By compacting the five phases into three stages the researcher was able to maintain a greater objectivity.

Technological Adoption Stage	Characteristics
Entry-Adoption 1	The basic 'built-in' capabilities of computer-based design and fabrication tools are made use of. Although the methods of working have changed, the outputs remain derivative of conventional subject domains.
Adaptation 2	The use of computer-based design and fabrication tools has become consistent with their application within a conventional industrial context. Productivity and efficiency are the primary contributions made by the use of the technologies.
Appropriation-Invention 3	Innovative applications of computer-based design and fabrication tools beyond their application within a conventional industrial context. The practitioner's practice can be defined by the use of computer-based technologies. Discontinuities from conventional subject domains are more likely through the practitioner's willingness and ability to experiment.

Table 9: The phases of technological integration

An example of a work that illustrates the 'Entry-Adoption' stage would be the untitled project by Angie To for the exhibition 'Intersculpt:Ohio 01'. To was invited to contribute to this exhibition by the researcher who also facilitated the computer-based component of the project. At the time To had been working on a series of slip cast ceramic objects (titled 'Risibles') that she had been coating with rubber. She had no previous experience of using computers in her work. To began this new work by making some pen drawings of shapes. These were scanned as 2D raster images and imported into the 3D modelling application Rhinoceros®. The drawings were then 'traced' by plotting nurbs curves as u-shaped sections (simply by clicking on points along the line and allowing the

software to interpolate a curve through those points). These sections were revolved around a central axis to create 3D vessel forms.

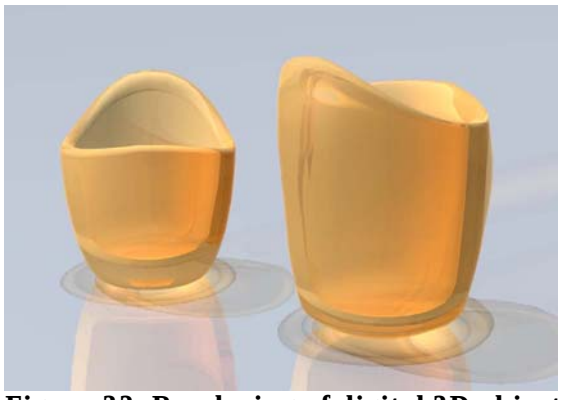

Figure 32: Rendering of digital 3D objects, 2001. Angie To

To then 'pushed and pulled' these forms around in the software (by selecting and moving control points) until she was satisfied with how they looked (Figure 32). These objects were simple and crude when measured against what is possible with CAD. The researcher built two physical objects from this data by the SLA® process. The completed resin objects were used by To as patterns to make plaster moulds from which she slip cast multiple ceramic forms which were fired in the traditional manner. To then applied a traditional hat-making felting process to cover the objects before dipping them in dye (Figure 33).

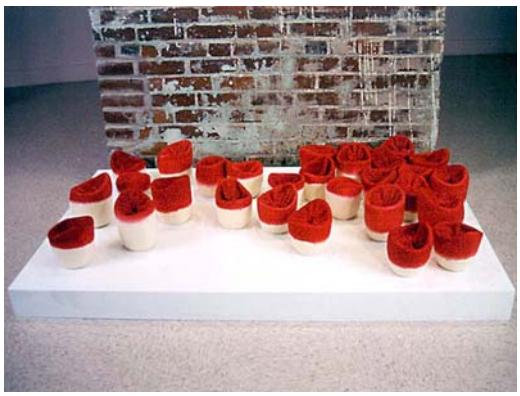

Figure 33: Untitled, 2001. Angie To

To could easily have made clay patterns from which to make moulds. There was nothing inherently about this project that needed to be done on a computer. However, through working in this way To discovered she was able to create transitions between surfaces that indicated a form pushing against the surface like bones under skin. This would not have been easily achieved by traditional methods and indicated a direction to develop future work. These objects are

representative of the 'Entry-Adoption' stage of technological integration because they explore the suite of 3D modelling software tools available rather than the development of a new visual grammar. This work is the result of a dialectical engagement between the practitioner and the tools used. Innovation here is largely the augmentation of existing practices by the application of computer-based technologies. This is a learning process – a practitioner needs practicable experience of using these technologies before conceptual realisations can be made.

Figure 34: 'Garden Tools', 1999. Tony Cragg

An example of a work that illustrates the 'Adaptation' stage would be artist Tony Cragg's 'Garden Tools' (Figure 34) for the 'At Home With Art' (Artsway, 2000) project with the DIY retailer Homebase, Tate Gallery and Arts Council England that was curated and organised by Colin Painter. Cragg's contribution to this project was in supplying the original objects which were made by conventional methods. These were scanned and surfaces generated in CAD from the captured data. This project then went through the various prototyping, detail design, production tooling and testing stages that would be expected (McDonald, 2001, p.224-226) of a consumer product. The only difference was the result was a hybrid 'sculpture-product' manufactured in a short run of 2,500 of each object. The computer-based design and fabrication tools in this project are used exactly as they were developed to be used. It makes no difference that Cragg did not do the digital work himself (in consumer product development designers usually produce sketches or surface data that is passed on to engineers to be completed for production). What matters in the determination of the 'Adaptation' stage is the use of the technologies is consistent with how they would be used within an

industrial context. Most of the objects in the database belong in the 'Entry-Adoption' or 'Adaptation' stages.

Figure 35: 'Bonechaise', 2006. Joris Laarman

An example of a work that illustrates the 'Appropriation-Invention' stage would be Joris Laarman's 'Bonechaise' (Figure 35) produced for the New York gallery Barry Friedman Ltd. and Dutch design collective Droog. Laarman worked with General Motors Engineering Europe (Opel) to use proprietary digital tools that mimic the growth patterns of bones that was originally developed for optimising car parts (to increase the strength of the part and a more efficient use of materials). The object derived from this process is cast in clear polyurethane resin. This project makes use of computer-based design tools that were developed for use in industry but it represents a shift in order of magnitude of the application of the technologies beyond their conventional industrial purpose.

The artifacts produced at the 'Appropriation-Invention' stage can be considered experimental in nature, with the objects having been made purposely to exploit the specific technologies used. The practitioners that are actively investigating and exploiting computer-based technologies at this stage of integration can be defined by their use of computer-based design and fabrication technologies. They are able to achieve innovation in terms of the conceptual design process and by the types of designed objects produced. New situations beyond single disciplinary domains are more likely to be explored at this stage.

The final subcategory of the 'sophistication' of an object is the level to which computer-based design and fabrication technologies have been used to create

meaning or experiences founded on the relationship between the user or audience and the object (see section 2.9.5). As discussed in Graham (1997) Cornock and Edmonds' taxonomy of interactivity subdivides art systems into the following categorisations: dynamic, reciprocal, participatory and interactive. This can be simplified and unpacked as three types of user-object relationship (see Table 10).

User-Object Relationship	Description
Static-Viewer 1	This is the model of reception usually applied in the reception of traditional sculpture. The function of the object is to act as a static focus for the aesthetic contemplation of the viewer. The viewer is the subject in this relationship whose action is to look at the object.
Reciprocal-User 2	This model of reception concerns the action of a user on an object. Both the user and the object are agents for each other. However, only the user is a subject in this relationship.
Interactive-Participant 3	This model of reception involves the object responding to the audience in some way. In this model the user becomes bound up as a participant in the experience. Both the object and the user can act as subjects in this relationship.

Table 10: Three types of user-object relationship

An example of the 'Static-Viewer' relationship would be Keith Brown's 'Geo' (Figure 36) produced for the 'International Rapid Prototyping Sculpture Exhibition'. This object is a sculpture produced from the application of computer-based design and fabrication tools. It has been modelled in a 3D modelling application and output using SLS® technology. Its function is to be looked at as a work of art.

Figure 36: 'Geo', 2005. Keith Brown

An example of the 'Reciprocal-User' relationship would be Unto This Last's 'Wavy Chair' (Figure 37) that has been made of more than one hundred individual parts, CNC cut from plywood and put together with interlocking joints. It has no additional fasteners. Its function is to be sat on as a chair. However, it could also be argued that it can act as a static focus for the aesthetic contemplation of the viewer. It can be looked at as both a work of art and as a functional designed object.

Figure 37: 'Wavy Chair', 2005. Unto This Last

An example of the 'Interactive-Participant' relationship would be Ken Rinaldo's 'Autotelematic Spider Bots' (Figure 38). These robots interact with their human observers, each other and their environment. These objects 'see' participants in the installation with ultrasonic sensors at the end of an antennae-like neck. They also have infrared sensors that allow them to see and avoid each other as they seek their recharge station. These robots were designed in a 3D modelling application. The custom parts used in their construction were produced in photopolymer epoxy resin by the SLA® process and articulated with Nylon monofilament. Their structural frames were cast from a rapid prototyped master pattern in polyurethane. In this way Rinaldo has applied computer-

based design and fabrication tools to create objects that respond to their audience as participants in the experience. Both the object and the audience can act as subjects in this relationship.

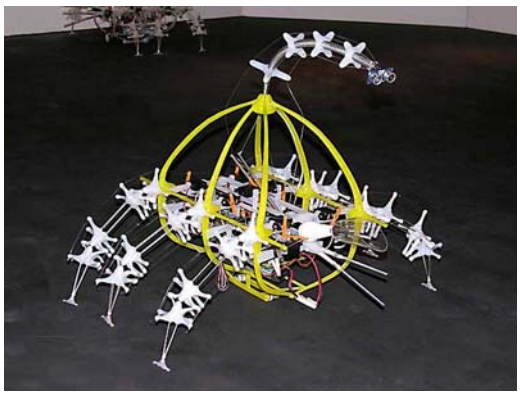

Figure 38: 'Autotelematic Spider Bots', 2006. Ken Rinaldo

We can derive a value for the sophistication of an object thus: Sophistication = Production (1-3) + Adoption (1-3) + Relationship (1-3). We can also derive a value (Total) based on the combined complexity and sophistication of the object thus: Total = Complexity (1-3) + Sophistication (3-9). This gives a scale (4-12) which was used to give a basic structure to the database of objects so further analysis could be conducted to indicate common properties of objects and to identify relationships between 'types' of objects.
Three further categories were added to the database. These were records of the technologies used (Tools) in the production of the objects. Also recorded was whether the object was produced as part of a commercial or non-commercial venture (Enterprise). So for example Keith Brown's 'Geo' (above) would be a non-commercially produced object and Unto This Last's 'Wavy Chair' is an example of a commercially-produced object. These simply allow further distinctions and clustering to be made.

The final category (Designed Object) also allows for further distinctions to be made and the objects to be clustered into types. This was derived from the systematic structure that evolved out of the categorisation described above. Six broad categories of types of designed object were discerned (see Table 11). Three categories make distinctions based on the functional capabilities that are built into the objects (augmented, autonomous and responsive) and three make

distinctions based on the means by which they were created (generative, input-driven and otherwise unobtainable).

Designed Object	Description
Augmented	The object has some kind of embedded technology that performs one or more predefined tasks.
Autonomous	The object contains some means of independent control (i.e. a robot). This characterisation implies a relationship between two agents: the designer that defines the control system and the autonomous object.
Generative	The object has been designed by using algorithms[60] which can evolve structures and objects based on predetermined rules, conditions and variables.
Input-Driven	The object is characterised by the technology used in its creation (for example 3D scanning or motion capture).
Otherwise Unobtainable[61]	The object could not have been made in any other way. The object can be characterised by having formal qualities that are unlikely to be achieved without the aid of a computer.
Responsive	The object incorporates technologies such as sensing mechanisms or dynamic media systems and interacts with its audience or user.

Table 11: Six broad categories of designed object

An example of an 'augmented' object would be Peter Cook and Colin Fournier's 'Kunsthaus Graz' (Figure 39). The form of the building itself is experimental and is an example of an 'otherwise unobtainable' object. However, the East facade of the Kunsthaus is augmented with a matrix of 930 circular fluorescent tubes called 'BIX' that was developed by 'realities:united' (Jan and Tim Edler). This operates as a low resolution screen which can display images at twenty frames per second. Thus the skin of the building functions as a platform for presenting content. An example of 'autonomous' objects would be Ken

[60] An algorithm is a finite list of well-defined instructions for accomplishing some task.
[61] The term 'otherwise unobtainable' (Harrod, 2002) replaced 'remediated' (Bolter & Grusin, 1999) because it was felt that the use of this term was overly value-laden and imposed an unintended hierarchy on the objects.

Rinaldo's 'Autotelematic Spider Bots' (above) that are robots which can perform tasks without continuous human assistance[62].

Figure 39: 'Kunsthaus Graz' & 'BIX', 2003. Peter Cook & Colin Fournier with realities:united

Theo Jansen's 'Strandbeests' (Figure 40) are examples of 'generative' objects. These constructions are designed by using genetic algorithms. Jansen uses software that simulates evolutionary processes to develop multilegged, wind-powered, creature-like structures capable of walking along a beach. These have been developed iteratively over fifteen years with each generation influencing the design of the next. Jansen uses plastic electrical conduit to make these structures but they are 'bred' in a computer.

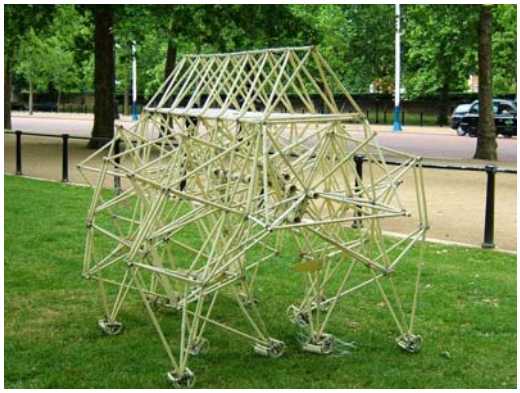

Figure 40: 'Strandbeest', 2001. Theo Jansen

The four members of the design collective Front (Sofia Lagerkvist, Charlotte von der Lancken, Anna Lindgren and Katja Sävström) made 'Sketch Furniture' (Figure 41) by recording pen strokes in the air by motion capture and outputting the results as rapid prototyped objects. These objects are examples of 'input-driven' objects that are defined by their method of production.

[62] Except when they run out of battery power before finding their recharge station.

Figure 41: 'Sketch Furniture', 2006. Front

An example of an 'otherwise unobtainable' object would be Anish Kapoor's 'Marsyas' (Figure 42) that was installed in the Turbine Hall at Tate Modern. Kapoor worked with Arup Advanced Geometry Unit (AGU) to develop the sculpture which is made of a PVC-coated polyester tensile membrane which stretches the entire length of the 150m hall. The object is anchored at each end by 30m diameter steel rings with another of these in the centre. A 3D video game engine was used so Kapoor could visualise how the form would be in place and to study the effects of colour, texture and lighting on it. This artwork was designed and engineered through an iterative process of computer-based visualisation, prototyping, analysis and could not have been realised on such a scale in any other way.

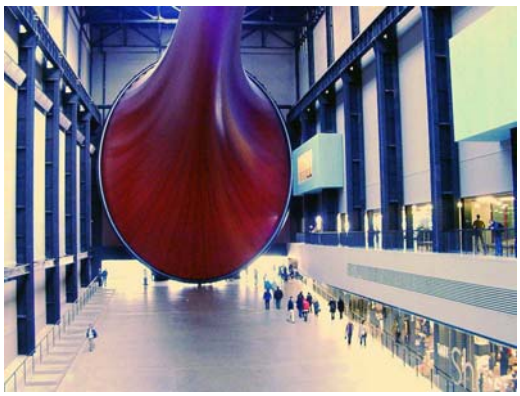

Figure 42: 'Marsyas', 2002. Anish Kapoor

An example of a 'responsive' object would be 'HypoSurface' (Figure 43) that was developed by the architectural/design practice dECOi (including Mark Goulthorpe, Mark Burry, Oliver Dering, Arnaud Descombes and Gabriele Evangelisti). This project was first proposed as an interactive real-time dynamic wall for the Hippodrome Theatre, Birmingham. This was never completed but a functioning prototype was built that operates through a matrix of actuators and

responds to the sound and movement of its audience or users. Subsequently, 'HypoSurface' has been commercialised as a display technology (see http://hyposurface.org/).

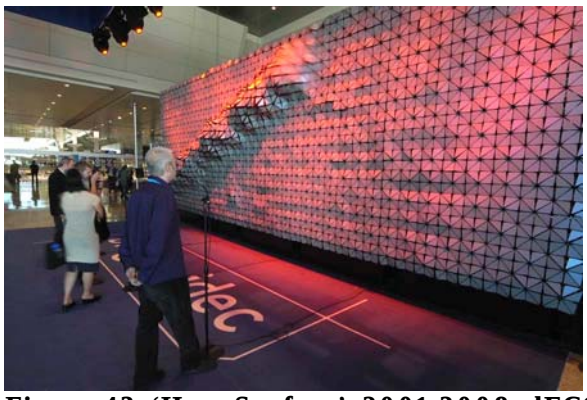

Figure 43: 'HypoSurface', 2001-2008. dECOi (Mark Goulthorpe)

The researcher has attempted to create a formalised system of analysis that is objective and can be applied to both objects that are available as primary sources and to those that are only available as secondary sources. The aim of this is to enable the researcher to focus on a systematic exploration and evaluation of what new types of computer-aided designed and manufactured objects are being created by art and design practitioners.

Category	Result
Image	
Title	Holy Ghost
Date	2006
Image Source	PBB_Dean.jpg
Code	PBB
Maker	FutureFactories
Discipline	Design
Website	http://www.futurefactories.com/
Notes	
Scale	Furniture
Structure	Assembly 2
Complexity	2
Production Stage	Conception & Production 2
Production	2
Technological Adoption	Appropriation Invention 3
Adoption	3
User Object Relationship	Reciprocal User 2
Relationship	2
Sophistication	7
Total	9
Tools	SLS®
Enterprise	Non-commercial
Designed Object	Generative

Table 12: A sample of the information stored in the object database

To illustrate how this formalised system of analysis works when applied to a specific object there now follows the example of Lionel T. Dean's 'Holy Ghost' commissioned for the 'PBB' exhibition (Table 12). The first ten categories record descriptive information about the object or objects. This includes an image of the object, the title ('Holy Ghost') of the work and the date (2006) it was produced. The file name of the indicative image was recorded (PBB_Dean.jpg). An indication of the source of the object was also recorded (PBB for the 'Perimeters, Boundaries and Borders' exhibition). The name of the practitioner is also recorded (FutureFactories is the name of Dean's company) and an indication of their disciplinary background (Lionel T. Dean primarily

identifies with the Design community). The address of this practitioners' website is indicated (http://www.futurefactories.com/). There is a space for any additional descriptive information about the object (Notes – nothing here in this case because extensive information is recorded elsewhere about this project).

The approximate scale of the objects is stated (Furniture). And that each object consists of a combination of parts (Assembly) is registered and given a value (2). This value is also restated as the indicator of the complexity of the objects so calculations can be performed with this category. The stage in the production cycle within which the use of digital design and fabrication technologies is integrated into the process is pointed out. This project was generated digitally by using algorithms which evolve structures and objects based on predetermined rules, conditions and variables. It has been output using SLS® technology. Therefore the design of the objects and the fabrication of the objects are indicated and given a value (Conception & Production 2). The technological reception of these objects by users or an audience could have been included in this case as the physical objects were shown alongside a screen onto which the rule-based, parametric metamorphosis of the chair design was rear-projected in real-time. However, the researcher chose not to include this aspect of the project as it served to act more as documentation of the process of making rather than an integral component of the work. This value is also restated as the indicator of the stages of production that utilise computer-based design and fabrication technologies.

The level to which computer-based design and fabrication technologies have been integrated within the practitioner's practice is recorded. This practitioner's practice can be defined by computer-based technologies. Dean is exploring innovative applications beyond the application of these technologies within a conventional industrial context. Therefore the relevant category is indicated and given a value (Appropriation-Invention 3). This value is also restated as a separate category to indicate the adoption level of the objects. These objects are fully functional as chairs. However, presented in the exhibition they act as a static focus for the aesthetic contemplation of the viewer. Both the user and the object are agents for each other. However, only the user is a subject in this relationship. Therefore the relevant category of user-object

relationship is indicated and given a value (Reciprocal-User 2). Again this value is also restated as a separate category to indicate the user-object relationship.

A subtotal is calculated for the sophistication of these objects (Sophistication = Production (2) + Adoption (3) + Relationship (2). This gives a value of seven for the 'sophistication' of these objects. This is combined with the 'complexity' of these objects Total = Complexity (2) + Sophistication (7). This gives a total value of nine for these objects. The principal technology used in the production of the objects is recorded (SLS®). Multiple technologies could have been indicated but it is considered that this is implicit the generative nature of the work. This work was commissioned for the 'PBB' exhibition and is not commercially available (at present). This status is recorded (Non-commercial). These objects have been designed based on predetermined rules, conditions and variables by using the Virtools[63] interactive, real-time development platform. This is indicated (Generative). This level of analysis has been applied across the entire database of one hundred and forty-eight selected objects produced by a wide array of practitioners within the past ten years.

This formalised, structuralist system of categorisation is by no means presented as a definitive method of analysis. It is acknowledged by the researcher that other readings of the same objects are possible, probable and likely. However, great care has been taken to attempt to maintain parity and rigour across the range of objects in this study. An aim of drilling down to this level of detail is so higher-level insights can be arrived at.

4.2.2 Application of database categories.

Based on the framework of analysis developed (above) the researcher sought to refine and test the theoretical picture of the field of study as revealed through this formalised system of categorisation. To distil meaning from this analytical framework the researcher needed to develop a method of parsing the database of objects, preferably in a visual manner. Various kinds of filtering mechanisms were considered. Since the criteria applied to these objects are not indexes of each other (i.e. the technological integration does not necessarily have any impact on the user-object relationship) it was discovered that a 'fuzzy'

[63] http://www.virtools.com/

classification system was necessary. Fuzzy classification[64] allows the simultaneous use of several criteria for sorting.

The researcher spent some time exploring methods that can be used in creating fuzzy classification systems. This included faceted classification. This is a dynamic method that allows the assignment of multiple classifications to an object, enabling the classifications to be ordered in multiple ways, rather than in a single, predetermined, taxonomic order[65]. However, the researcher ran into difficulties with the various software applications available for this analysis which is used most frequently in scientific contexts. Most of these require the user to write some code in Extensible Mark-up Language (XML). Eventually the researcher realised that this was a study in itself and the desired ability to be able to dynamically 'play' with the data was more of an effect than a result.

Instead the researcher formed groups around 'typical' exemplars – in the same way that examples from the database have been indicated above. Each object in the database could be compared with these exemplars and assigned to the group that it most resembled. This was done iteratively with new groups added or subtracted as necessary. This process was conducted both electronically and with paper printouts on large sheets of paper. Electronic methods included Excel spreadsheets exported from FileMaker Pro® and visual versions produced 'manually' in the mind-mapping software application Inspiration® and by importing the Excel spreadsheets into the data visualisation application Omniscope® (Figure 44).

[64] In fuzzy classification data elements can belong to more than one category, and associated with each element is a set of membership levels. These indicate the strength of the association between that data element and a particular category. See: http://www.uiah.fi/projects/metodi/110.htm

[65] The most prominent use of faceted classification is in faceted navigation systems that enable a user to navigate information hierarchically, going from a category to its sub-categories, but choosing the order in which the categories are presented. This contrasts with traditional taxonomies in which the hierarchy of categories is fixed and unchanging.
http://en.wikipedia.org/wiki/Faceted_classification

Figure 44: Database categories in the data visualisation application Omniscope®

It occurred to the researcher that this venture was counter to the proposition set out in the aims and objectives of the research project. If a broad, pluralist category of designed object was the goal of this study it does not serve the interests of this research to immediately reassert subcategories which essentially break down to re-establish differentiation under new labels. However, this was a useful exercise in establishing that this research project could not result in a taxonomical coin-sorter into which diverse objects could be poured as loose change. This structuralist approach is however useful in suggesting first principles upon which to begin defining boundaries around which a cross-disciplinary discourse can begin to be built around.

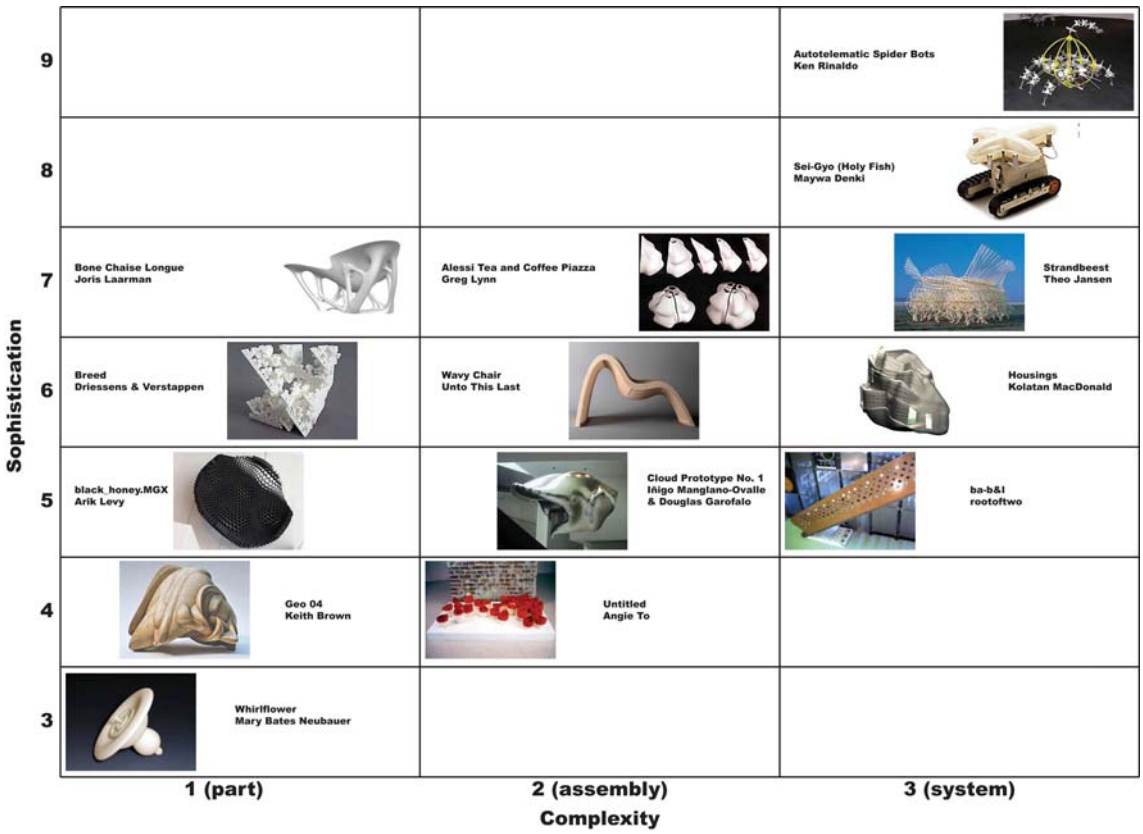

Figure 45: This simple schema shows increasing 'complexity' along the x-axis and increasing 'sophistication' on the y-axis

To try to clarify how this operates it is useful to look at some examples (Figure 45). This simple schema shows increasing 'complexity' along the x-axis and increasing 'sophistication' on the y-axis. So moving from left to right we have transitions from single, static objects to conjunctions of objects to networks of objects that are activated by increasing amounts of embedded technology. Likewise moving from the bottom of the table to the top of the table we see transitions from objects produced by the basic capabilities of computer-based design and fabrication tools to more experimental applications beyond the conventional use of these technologies.

Perhaps the most apparent example to highlight from this arbitrary selected grouping is the 'evolution' that can be interpreted between Keith Brown's 'Geo 04', Iñigo Manglano-Ovalle & Douglas Garofalo's 'Cloud Prototype No. 1' and Kolatan MacDonald's 'Housings'. These three objects are all formally similar blobs. Brown's 'Geo 04' is a sculpture created by manually manipulating torus knots (doughnuts) in the 3D modelling application 3ds Max® and building the result on a laminated object manufacturing (LOM) machine. Garofalo and

Manglano-Ovalle's 'Cloud Prototype No. 1' (also a sculpture) was derived from the numerical data scanned from a thirty-kilometre wide thundercloud and then sculpted by CNC machines to produce interlocking fibreglass components which were covered with titanium alloy foil. Kolatan MacDonald's 'Housings' are experimental designs for mass-customised, prefabricated buildings. These were generated by digitally blending between programmatic layouts of rooms and a series of shape targets. Brown has used his extensive experience as a traditional sculptor to make visual-based, qualitative decisions on the development of the form in much the same way that would have been done traditionally with the manipulation of physical matter. His object consists of one solid part made up of layers of laminated paper and glue. Manglano-Ovalle and Garofalo have made use of scanning technology to 'capture' the form of naturally occurring water vapour and materialise this by a process of machining, casting, assembling and coating surfaces. Kolatan MacDonald's project explores various composite materials and digital production technologies to investigate if a generative, hybrid structure can outperform existing normative types in building design. These three objects are formally similar and are dependent on common, computer-based technologies for their existence. However, they vary dramatically in scale, context and demonstrate varying levels of complexity in their construction.

Similarly, if we look at the development of the objects from Mary Bates Neubauer's 'Whirlflower' through Arik Levy's 'black_honey.MGX' to Joris Laarman's 'Bonechaise' we see a series of static objects that increasingly make use of the data processing capabilities of the computer. 'Whirlflower' is the result of a spline profile lathed or revolved about an axis. It is a visually complex form that is derived from a single operation from the basic 'built-in' capabilities of computer-based design software. As we move up that column the objects increasingly rely on more computer-controlled operations even though the result is always a single part or object until we reach Laarman's 'Bonechaise' that uses computer-based design tools that were developed for use in the auto industry to 'grow' the form.

Looking up the second column of the table we see increasing amounts of the integration of the application of computer-based technologies to control the

production of form. To's 'Untitled' has been 3D modelled, rapid prototyped and manually slip cast. Garofalo and Manglano-Ovalle's 'Cloud Prototype No. 1' has been 3D scanned, CNC milled and manually cast and assembled. Unto This Last's 'Wavy Chair' has been 3D modelled, digitally sliced and CNC cut before manual assembly. Lynn's 'Alessi Tea and Coffee Piazza' was produced by methods developed to manufacture components for stealth aircraft using of heat and pressure. At each level the use of the computer is more critical at each stage of the production of the final objects.

In the third column we see augmented objects such as rootoftwo's 'bab&l' where the application of computer-based technologies is in the creation of custom speakers for a self-mixing sound installation. We see generative objects such as Kolatan MacDonald's 'Housings' that are selected from a 'gene-pool' of variables and Jansen's 'Strandbeest' where genetic algorithms are used to develop creature-like structures capable of walking. Also we see autonomous objects such as Maywa Denki's 'Sei-Gyo' (Holy Fish) a fish-controlled vehicle that moves in the same direction that its 'driver' swims and Rinaldo's 'Autotelematic Spider Bots' that interact with their audience, one another and their environment. In these examples, computer-designed and fabricated components work with other technologies to create systems. New properties arise from these objects because of simple interactions or rules within these systems.

Looking across the seventh level of 'sophistication' we see Laarman's 'Bonechaise'. This is a single object that was 'grown' and optimised by computer-based design tools developed for use in the car industry. Lynn's 'Alessi Tea and Coffee Piazza' is available as 50,000 unique, mass-produced sets of objects by methods developed to manufacture military aircraft. Jansen's 'Strandbeest' is made of a system of cheap plastic tubes and much trial and error. Here we see that in this analytical framework a group of interrelated elements comprising a unified whole (system) gains parity with a single object (part) or a combination of parts (assembly) made with far more expensive and 'sophisticated' technologies.

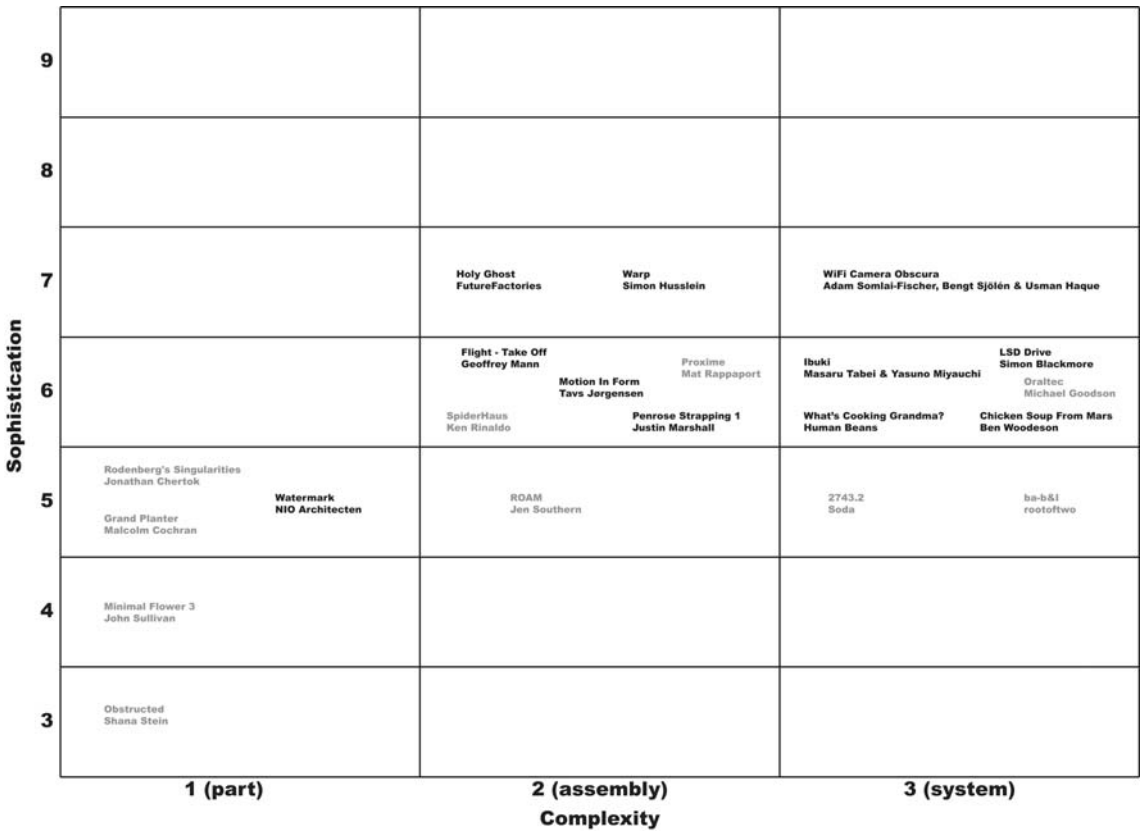

Figure 46: Increasing 'complexity' and 'sophistication' as applied to the works selected for the 'Perimeters, Boundaries and Borders' exhibition and (in gray) works from exhibitions the researcher curated previously

If we then apply this rationale to the works selected for the 'PBB' exhibition we arrive at (Figure 46). Some of the technologies used in these works do not fit neatly into this schema ('What's Cooking Grandma?' and 'Chicken Soup From Mars' can be viewed as both assemblies and systems depending on which aspects are viewed. In this version these have been included as systems. 'Cyclone.soc' has been omitted because it is a projection and not an object). Nevertheless, we see a clustering of the projects across the middle of the table in levels five through seven. The researcher's aim with this exhibition was to 'raise the bar' from what had been done previously. Some of the works from exhibitions curated by the researcher in the past have been plotted on this table in gray. Most of the works shown previously are located in levels four through six. This can be taken as an indication the works selected for the 'PBB' exhibition are more 'sophisticated' and 'complex'. This indicates these works are less likely to be static works for aesthetic contemplation. They represent a more integrated use of computer-based design and fabrication technologies by the practitioners that made them and they are more likely to engage an audience in an interactive relationship.

4.3 A survey of international practitioners

The researcher gathered data from a survey of practitioners that use computer-based design and fabrication tools from across the 3D disciplines of art and design. The purpose of this survey was to develop an understanding of the current use of these technologies in art and design. Also, to establish how practitioners think about and engage with these technologies and generate an understanding of how practitioners engage with other art and design disciplines. These practitioners represent a spectrum of practices from across disciplines and from a wide range of approaches to their use of computer-based design and fabrication technologies.

Q1. Your Name?

	First Name	Relationship	Status
1.	Anne Hayes	Unknown (Fast-uk)	Responded
2.	Anthony Padgett	Unknown (Fast-uk)	Responded
3.	Ben Langlands & Nikki Bell	Exemplar (DesignArt)	No Response
4.	Bathsheba Grossman	Unknown (Intersculpt)	Responded
5.	Brian Adams	Unknown (CALM)	Responded
6.	Brit Bunkley (PBB)	Known (Fast-uk)	Responded
7.	Bruce Beasley	Unknown (IRPSE)	Responded
8.	Arik Levy (PBB)	Exemplar (.MGX)	No Response
9.	Jonathan Chertok	Known (Fast-uk)	Responded
10.	Craig Kalpakjian	Exemplar (010101)	Responded
11.	Dan Collins	Unknown (Telesculpture)	Responded
12.	Drummond Masterton	Known (Fast-uk)	Responded
13.	Elona Van Gent	Unknown (Intersculpt)	Responded
14.	Fiona Raby	Exemplar (Critical Design)	No Response
15.	Gordon Burnett	Known (Gray's)	No Response
16.	George Hart	Unknown (Telesculpture)	Responded
17.	Glenn Davidson	Unknown (Fast-uk)	No Response
18.	Human Beans (PBB)	Exemplar (Critical Design)	Responded
19.	Ian Gwilt	Unknown (Intersculpt)	No Response
20.	Lise Anne Couture & Hani Rashid	Exemplar (4Dspace)	No Response

21.	Janne Kyttanen & Jiri Evenhuis	Exemplar (.MGX)	Declined
22.	Miam Miam	Exemplar (Critical Design)	No Response
23.	Lars Spuybroek	Exemplar (4Dspace)	Responded
24.	Simon Goldin, Jakob Senneby & Ben Reece	Unknown (DesignArt)	No Response
25.	Ora Ito	Exemplar (DesignArt)	No Response
26.	sixteen*(makers)	Exemplar (4Dspace)	No Response
27.	Vogt + Weizenegger	Exemplar (DesignArt)	No Response
28.	Keith Brown	Known (Fast-uk)	Responded
29.	Jon Pengelly	Known (Gray's)	No Response
30.	Justin Marshall (PBB)	Known (Autonomatic)	Responded
31.	Katie Bunnell	Known (Autonomatic)	Responded
32.	Sulan Kolatan	Exemplar (4Dspace)	No Response
33.	Lionel Dean (PBB)	Known (Autonomatic)	Declined
34.	William MacDonald	Exemplar (4Dspace)	No Response
35.	Thomas Heatherwick	Exemplar (Fabricated Buildings)	Responded
36.	Karin Sander	Exemplar (DesignArt)	No Response
37.	O. Makai Smith	Unknown (IRPSE)	Responded
38.	Mary Bates Neubauer	Unknown (Intersculpt)	Responded
39.	Nobumichi Tosa (Maywa Denki)	Exemplar (Device Art)	No Response
40.	Maurice Nio (PBB)	Exemplar (Fabricated Buildings)	No Response
41.	Greg Lynn	Exemplar (4Dspace)	Responded
42.	Erwin Driessens & Maria Verstappen	Exemplar (DesignArt)	Responded
43.	Ken Rinaldo	Known (OSU)	Responded
44.	Rob Price	Known (Critical Design)	No Response
45.	Ron Arad	Exemplar (DesignArt)	No Response
46.	Robert Michael Smith	Known (Intersculpt)	Responded
47.	Todd Slaughter	Known (OSU)	Responded
48.	Robert Lazzarini	Exemplar (BitStreams)	No Response
49.	SHoP Architects	Exemplar (Fabricated Buildings)	Responded

50.	Tavs Jørgensen (PBB)	Known (Autonomatic)	Responded
51.	Tom Longtin	Unknown (Intersculpt)	No Response
52.	Tobias Wong	Exemplar (Critical Design)	Declined
53.	Anthony Dunne	Exemplar (Critical Design)	No Response
54.	Mary Hale-Visser	Unknown (Intersculpt)	No Response
55.	Michael Laforte	Unknown (Mind Into Matter)	Responded
56.	Michael Rees	Known (Intersculpt)	No Response
57.	Amy Youngs	Known (OSU)	Responded

Q2. How would you identify the community of practice or discipline that you most closely relate to? (e.g. Architecture, Product Design, Sculpture, etc. If more than one please indicate.)

Response	Anticipated	Actual	% Response
Art	21 (36.8%)	13 (22.8%)	48.1%
Hybrid	15 (26.4%)	8 (14%)	29.6%
Craft	5 (8.8%)	4 (7%)	14.8%
Product Design	8 (14%)	1 (1.8%)	3.7%
Architecture	8 (14%)	1 (1.8%)	3.7%
No Response	0	30 (52.6%)	-
Total	**57**	**57**	**27**

Of the 27 responses received 8 practitioners (29.6%) mentioned more than one discipline. This is considered to indicate they think of themselves to have a hybrid or cross-disciplinary practice. This number is slightly higher than anticipated. Of these 5 (62.5%) cited both sculpture and architecture. The remaining 3 (37.5%) hybrid practitioners were represented by 1 (12.5%) practitioner each citing the combination of architecture and product design; sculpture and product design; and sculpture and digital printmaking. It is worth noting that 5 (18.5%) of the practitioners made the distinction that their practice was digital in nature (e.g. 'digital sculpture' as opposed to 'sculpture').

Q3. When you see the term '3D computer technologies' what does it mean to you?

As has been noted elsewhere (see section 1.0) the researcher has not been using the term 'CAD/CAM' to describe the use of computer-based design and fabrication tools to ends beyond the pragmatic aspect of increased speed and productivity. This question was asked by the researcher to elicit responses that might indicate how broad a range of technologies this might entail. Surprisingly only 1 (3.7%) practitioner responded with just CAD/CAM. The responses indicate a more expanded conception of the range of technologies than any single practitioner would be likely to come up with. It is worth noting that 2 (7.4%) of these practitioners specifically indicated that meant 'more than drawing'.

Indicative Term	Number of References
Rapid Prototyping	10
Design	9
Modelling	9
Software	8
CNC	7
Output	7
CAD	6
Animation	5
Creative	5
Digital	5
Scanning	5
Input	4
Manufacture	4
Physical	4
Virtual	4
CAM	3
Fabrication	3
Generation	3
Robotics	3
Visualisation	3
Haptics	2
Rendering	2
Reverse Engineering	2
CAVEs	1
Computer Games	1
Hardware	1
Holography	1
Sensing	1
Simulation	1
Special Effects	1

Q4. Please indicate which of the following technologies you consider are part of your 'digital toolbox'.

The use of the 'toolbox' metaphor caused some ambiguity here. A number of practitioners checked every box. It is not clear if this means they have made use of these technologies previously or if it is merely an indication that they are aware of them and would consider using them. On reflection the question could have been more specific and asked which technologies had actually been used by the practitioners.

Technology	Response Percent	Response Total
3D computer aided design (CAD)	100%	27
3D printing	85.2%	23
2D computer aided design (CAD)	77.8%	21
Computer numerically controlled (CNC) cutting/milling	66.7%	18
Stereolithography (SLA®)	59.3%	16
Fused deposition modelling (FDM™)	51.9%	14
Selective laser sintering (SLS®)	51.9%	14
3D object scanning	44.4%	12
Laminated object manufacture (LOM™)	44.4%	12
Other	44.4%	12
Total Respondents		27

Other technologies indicated were:

Input	Output
Haptic input technologies	2D prints
Motion capture systems	Circuit board manufacturing
	Mould making
	Subsurface laser damage in glass
	Stereoscopic and holographic projection systems
	Special effects, animation and video

Q5. When did you first make use of these technologies?

Year	Response Percent	Response Total
1983	3.7%	1
1987	3.7%	1
1988	3.7%	1
1989	3.7%	1
1990	7.4%	2
1992	3.7%	1
1993	7.4%	2
1995	11.1%	3
1996	18.5%	5
1997	14.8%	4
1998	7.4%	2
1999	3.7%	1
2001	11.1%	3
Total Respondents		27

Q6. What is the most advanced level of training you have had with these technologies?

The majority of practitioners indicated they were 'self-taught'. It was clear that their experience of using the technologies was task-related and project-based.

Training	Response Percent	Response Total
Self-taught	51.9%	14
Other	33.3%	9
Workshop training	7.4%	2
University degree training	3.7%	1
Job-related industrial training	3.7%	1
No training – work with technical facilitator/collaborator	0%	0
Total Respondents		27

The additional responses consisted of answers that fitted into multiple categories. The only new category mentioned was that 3 (11.1%) practitioners stated they taught the use of these technologies.

Training	Response Percent	Response Total
Self-taught	18.5%	5
Job-related industrial training	18.5%	5
University degree training	14.8%	4
Teaching	11.1%	3
Worked with technical facilitator	3.7%	1

Q7. Please describe how you make use of these technologies in your practice (e.g. concept development, design-to-order, fabrication, pre-visualisation, prototyping, etc.)

These practitioners were selected based on their use of computer-based design and fabrication technologies. Therefore it was anticipated that their use would permeate throughout all stages of their practice. An interesting point arises from this – is there such a thing as a 'casual' user of these technologies? Or does the use of computer-based design and fabrication technologies become a defining characteristic of their user's practice?

Use	References
Prototyping	11
Fabrication	11
All of the above	10
Visualisation	8
Concept development	8
Modelling	7
Printing	6
Manufacturing	5
Design	4
Communication	3
Animation	3
Presentation	2
Generation	2
Rendering	2
Scanning	2
Analysis	1
Simulation	1
Testing	1

Q8. In the process of using these technologies have you come to new ideas or conclusions – how have these technologies had an impact on your practice?

All the respondents that answered this question stated that computer-based design and fabrication technologies had made an impact on what they do.

Impact	References
New formal possibilities	9 (36%)
Transformation of practice	5 (20%)
Integration of traditional methods and computer-based technologies	5 (20%)
Enhanced means of communication	2 (8%)
Developed own tools (through necessity)	2 (8%)
Increased productivity	2 (8%)
Total Respondents	25
Skipped this question	2

Q9. What (for you) is the key benefit of using these technologies?

The practitioners considered the unique opportunities offered by these technologies to create objects not possible to produce by other means as their key benefit. This recalls Harrod's 'otherwise unobtainable' – indeed 3 practitioners (11%) referenced or paraphrased this term. It should also be noted the terms 'complex' or 'complexity' were used 11 times in the responses to this question.

Benefit	References
Otherwise Unobtainable	12 (48%)
Productivity	9 (36%)
Collaborative	2 (8%)
Conceptual	2 (8%)
Total Respondents	25
Skipped this question	2

Q10. What (for you) is the key limitation of using these technologies?

The most prevalent answer pointed out by these practitioners was the expense of using these technologies with 8 (29.6%) identifying cost as the key limitation.

Limit	References
Resources (access, cost, scale, training)	14 (56%)
Lack of haptic response	3 (12%)
Tool-derived aesthetics	3 (12%)
Non-intuitive software interfaces	2 (8%)
Range of RP materials	2 (8%)
None	1 (4%)
Total Respondents	25
Skipped this question	2

Q11. What do you consider constitutes 'sophistication' in the use of these technologies?

The practitioners indicated the cognitive and technical skill in the use of software and hardware to ends which are not possible (or could not be done as effectively) by other means were 'sophisticated'. They identified 'sophisticated' objects as having innovative qualities that transcend the conventional applications of straight modelling and production, moving beyond mere, gestural form-making. The practitioners also stated that use of these technologies becomes 'sophisticated' when there is a fluid engagement of ideas, model and output – when use of the tools comes 'as second nature'. Furthermore, 'sophistication' is indicated as more than merely employing the technology for its own sake. Some practitioners 5 (18.5%) had no particular relation to the term and stated as much or did not respond.

Sophistication	References
Demonstrated expertise, control and/or creativity	7 (31.8%)
Innovation	6 (27.3%)
2nd nature tool use	6 (27.3%)
Otherwise unobtainable	2 (9.1%)
Not for own sake	1 (4.5%)
Total Respondents	22
Skipped this question	5

Q12. What term best describes the relationship between your work and its audience?

This question was posed by the researcher as a prompt for the practitioners to reflect on how their work is accessed and the role of consumers within this. It was clear from the responses and those that chose not to respond that for some practitioners this question was not framed clearly enough or bore no relation to how the practitioner conceives of their own practice.

Relationship	Response Percent	Response Total
Other	30.4%	7
Viewer	21.7%	5
Co-creator	13%	3
End-user	13%	3
Participant	13%	3
Client	4.3%	1
Customer	4.3%	1
Total Respondents		23
Skipped this question		4

Q13. Which of the following discourse communities would you say you are engaged with? (Select as many as apply).

This question was asked to gather responses from the practitioners about which fields they consider are related or relevant to their practice.

Community	Response Percent	Response Total
Art	88.5%	23
Sculpture	80.8%	21
Design	76.9%	20
Computer Generated Imagery	53.8%	14
Craft	50%	13
Engineering	50%	13
Architecture	42.3%	11
New Media	42.3%	11
Mathematics	34.6%	9
Virtual Reality	30.8%	8
Computer Science	26.9%	7
Human Computer Interaction	19.2%	5
Printmaking	19.2%	5
Other	15.4%	4
Total Respondents		26
Skipped this question		1

Q14. Please describe the nature of this engagement with these discourse communities.

Nature of Engagement	References
Exhibition	10
Education	8
Research	7
Practice	5
Conference	4
Publication	4
Dialogue	3
Represent a funding body	3
Internet	2
Collaboration	1
Interdisciplinary	1
Multidisciplinary	1
Total Respondents	22
Skipped this question	5

Q15. Name up to 5 practitioners that you would identify as exemplary users of 3D computer technologies.

(Figure 47) shows the survey respondents (gray boxes) and the identified exemplary practitioners (ellipses). (Figure 48) shows the same information with all the identified exemplary practitioners with only a single reference removed. This shows the discourse communities are less broad and more likely to be based on working relationships.

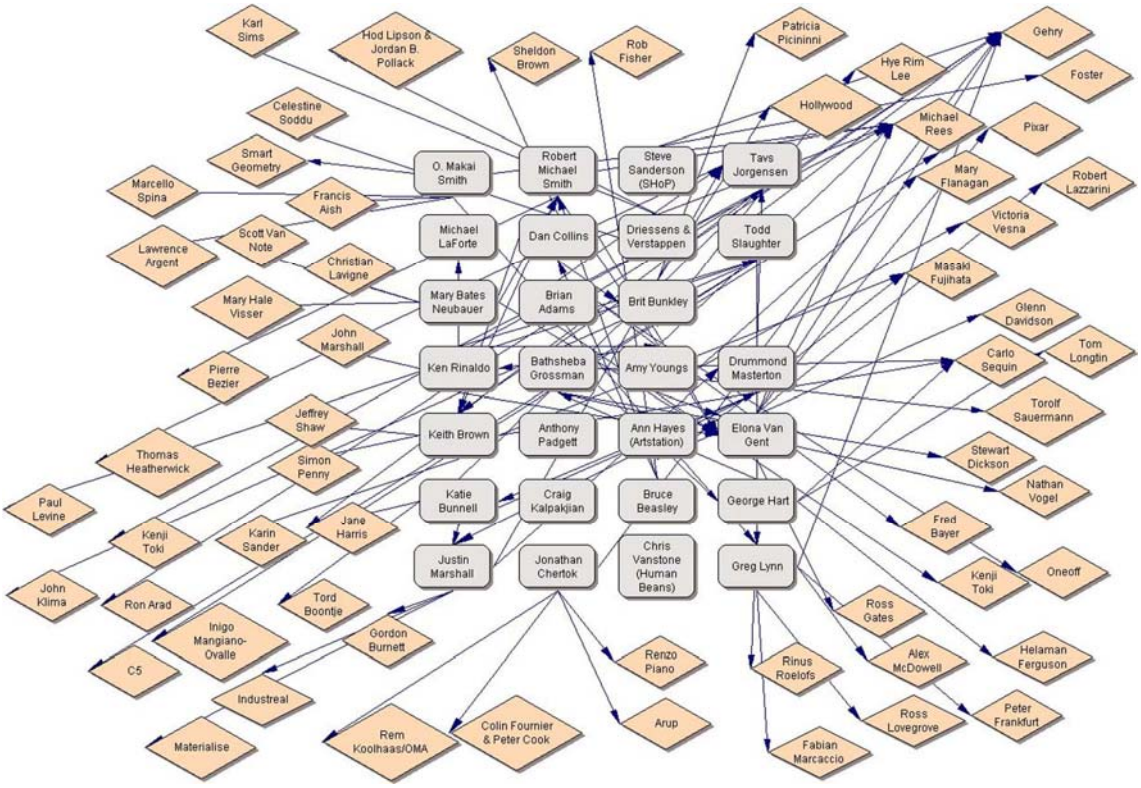

Figure 47: A map of exemplary practitioners

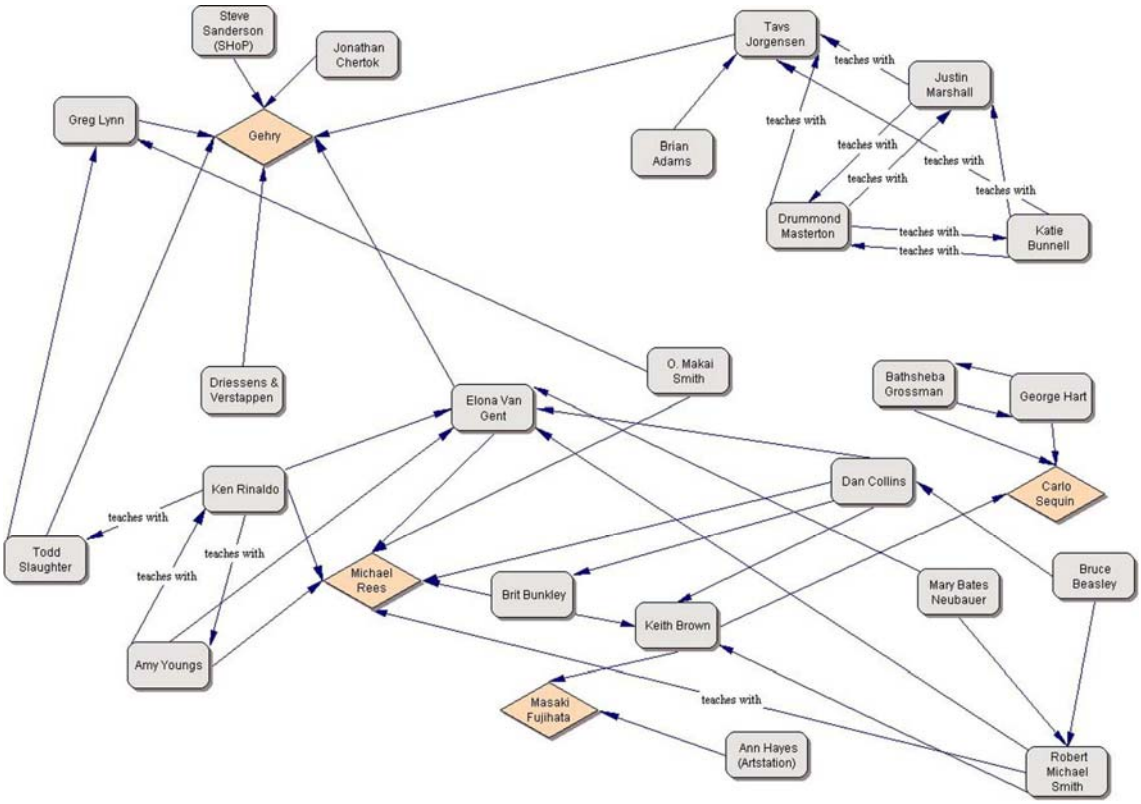

Figure 48: A map of exemplary practitioners with multiple citations

4.4 Development of a curatorial framework

The beginning of the exhibition that forms the centrepiece of this research project can be dated to not long after the submission[66] of the Regional Arts Lottery Programme (RALP) final report for the exhibition 'Intersculpt:uk 03'[67]. 'Intersculpt:uk 03', was presented by Fast-uk[68] which is based in Manchester[69] in the North West of England. This previous exhibition consisted of 18 works by both emerging and established artists working with various technologies. These artists were selected from a pool of forty-seven applicants from an open call. Additional works were chosen from the international 'Intersculpt' participant sites and project partners. Although this exhibition was generally successful the researcher was left with the notion the curatorial vision for the exhibition had been compromised by the inclusion of certain works in return for institutional, financial and in-kind support. The choice of venue had also had major implications on the audience for the exhibition. While we exceeded expectations for visitors (1650) we had hoped to attract more of a gallery-going audience as well as the existing museum visitors.

Having reflected on this experience the researcher set out some objectives for a themed exhibition exploring 3D practices in digital art to be exhibited at CUBE (Centre for the Urban Built Environment), Cornerhouse or another suitable exhibition space. The researcher's intention was to commission new works as part of this exhibition and move away from the 'Intersculpt' model - possibly by making partnerships with other organisations. Nevertheless, in this outline the exhibition was targeted to coincide in November, 2005 with the next 'Intersculpt' event. This was primarily because participation in an international activity had been viewed as favourable in previous funding applications. The general idea was to try to set a higher standard curatorially and to have a more coherent exhibition that reflected the creative use of 3D computer technologies.

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[66] Completed 01/03/2004.

[67] Intersculpt:uk 03 was held from 10-26/10/2003 at the Museum of Science and Industry in Manchester (MSIM). http://www.fastuk.org.uk/is03.htm

[68] Fast-uk is an artist-led organisation dedicated to promoting and encouraging artists that use digital and or electronic technologies in some part of their practice. The organisation's board consists of Keith Brown as founder and president, the researcher as vice president and Cezanne Charles as treasurer.

[69] Where the researcher was living at the time.

The researcher continued developing this proposal for an exhibition and workshops that would demonstrate the impact of digital technologies on contemporary art and design practice. This would consist of works 'not limited by genre' as far as they responded to the legacy of sculptural tradition[70] in some way. The vision was to solicit works that would represent a broad range of techniques and creative practices.

In October, 2004 the researcher began the current research project. The researcher had responded to the call for a visual artist/designer to undertake a practice-based PhD examining the notion that new creative opportunities exist for designers/artists because of recent developments in 3D imaging, rapid prototyping and rapid manufacturing technologies. From this point onwards the research work and the proposed exhibition would continue to converge and eventually overlap. Early in 2005 Fast-uk submitted an application for £36,600[71] to Arts Council England's (ACE) grants for individuals, organisations and national touring. This proposal had the working title: 'Intersculpt:uk 05 - Perimeters, Boundaries and Dimensions'[72]. Specifically the request was for funds to support:

- a physical exhibition of works that utilise diverse technologies specifically in relation to 3D/sculptural practice, design and architecture by up to 17 regional, national and international practitioners
- a series of workshops/training days for artists
- a panel discussion about how technological innovation in 3D visualisation and manufacturing is impacting on the disciplines of sculpture, architecture and industrial design and how the convergence of these disciplines has been enabled and accelerated by the development and proliferation of computer visualisation and manufacturing processes

The exhibition was to contain a mixture of existing works (selected from an open call process) and new works (from practitioners selected and invited to participate by the curatorial team in relation to curatorial theme/brief). These proposals were to form the basis for a panel discussion event. The exhibition

[70] Fast-uk was founded in 1998, originally to support sculptors working with computer technologies.
[71] Completed by the researcher and Cezanne Charles.
[72] The researcher had drafted a paper titled 'Perimeters, Boundaries, Borders: Post-Objects in the Emergent Field' on 06/12/2004. The use of 'Dimensions' in the title was chosen to make some distinction from this paper which ended up being submitted as an abstract for the Computer-Aided Industrial Design & Conceptual Design (CAID&CD) Conference at Delft University of Technology (TUDelft). This paper was later published (MARSHALL and PENGELLY, 2005a)

was scheduled for mid-November 2005 and was to be presented in partnership with Digital Summer and MIRIAD (Manchester Institute for Research and Innovation in Art and Design). Both had been project partners on 'Intersculpt:uk 03'. CUBE (Centre for the Urban Built Environment) was identified as the ideal venue. The proposed exhibition was to move away from the survey aspects of the previous 'Intersculpt:uk' exhibitions and would respond not only to a theme but to developments and ideas in the field coming from a diversity of practitioners from across 3D art and design disciplines.

Fast-uk pledged to match any funds received from ACE through earned income, sponsorship/contributed income and in-kind support. The programme would be managed and run using a system similar to 'Intersculpt:uk 03'. A part-time freelance project and outreach coordinator would be contracted to manage 'Intersculpt:uk 05'. The overall direction of the project would be overseen and administered by the management team[73] with programmatic decisions made by the curatorial team[74]. To better target and reach our audience it was decided to contract with a freelance arts pr/marketing professional.

We received an offer of £30,000 from ACE for 'Perimeters, Boundaries and Dimensions'. The reason for the partial funding was attributed to pressure on funds. We needed confirmation of dates, venue and confirmation of partner support before funds would be released. An invitation for the Lancaster-based not-for-profit digital arts organisation folly[75] to become a project partner was extended. This was positively received they were planning a festival event that would happen at the same time and would coordinate this with our exhibition.

The researcher had been working on a project with Arts Magnet[76] and was put in touch with Adrian Slatcher ICT Development Officer at CUBE by its Director Hannah Rudman. The researcher sent a brief synopsis of 'Perimeters, Boundaries and Dimensions' to both these individuals and asked if it was possible to schedule a meeting to discuss this at their earliest convenience. We

[73] Fast-uk and project partners.
[74] Fast-uk and project partners, again.
[75] The researcher had previous connections through his studio practice with this organisation. http://www.folly.co.uk/
[76] A now-defunct Manchester-based digital development agency for the arts.

were informed the Manchester Digital Development Agency (MDDA) was taking over the lease of the CUBE space. Dave Carter, Head of MDDA was contacted and responded that he was happy to support the exhibition. Professor John Hyatt[77] was also approached and committed to a contribution from MIRIAD.

A meeting was convened at the MDDA's offices in the CUBE Building on Portland Street in Manchester. We presented an overview of the project. Based on this we were able to confirm use of the CUBE gallery, its technical support and security personnel, data connectivity and insurance coverage. We also confirmed partnership support in the form of audience development and marketing from Arts Magnet and access to Manchester City Council's resources for marketing and communications. These in-kind contributions would go towards a match for the funds received from ACE.

No progress was made for some time on the ownership of the CUBE Building. We still needed to sign off on dates, venue and partner support before we could advertise for a project manager. Finally we became aware that CUBE was now being run by the Centre for Construction Innovation[78]. With not enough time to renegotiate the terms of the use of the space we made a request to ACE to move the grant period of the programme and extend the project timeline to an end date of November 2006. This meant the event would not coincide with the other international 'Intersculpt' events. We also had to find new partners for the project to secure matching funds for the project. ACE replied they were happy to extend the timeline. This presented an opportunity to redefine the scope of the project.

folly contacted us again. After updating them on where we were with the project they asked if we would consider moving it to Lancaster. We responded that we had no problem with the show being in Lancaster so long as it was in the 'right' venue. They responded there were many possibilities of spaces we could explore throughout the city to host the exhibition. It was indicated that we might be able to secure spaces within the Storey Institute, new gallery spaces in St.

[77] Director of MIRIAD and Head of the Graduate School in the Faculty of Art and Design at Manchester Metropolitan University.
[78] An Enterprise Centre hosted by the University of Salford.

Martins College, the Ashton Memorial and other developments. However, timing was an issue with this. The Storey Institute was planned to fully close to the public for redevelopment in September and we were thinking that October would be the best time to have the exhibition when the academic term had restarted after the summer break. A meeting was set up between Fast-uk and folly at folly's temporary offices in Lancaster to discuss potential options. Before the meeting the researcher sent a document to folly staff outlining the scope of the project. This consisted of sections from the original ACE grant application with sections from a paper (Marshall and Pengelly, 2006) the researcher had been working on. The modified version of the ACOT model of technology adoption (see section 3.6.1) was presented in this document and it was stated that for the exhibition we wanted to concentrate on work that meets the requirements of the 'Appropriation' and 'Invention' phases. The examples from this paper were also used to illustrate the work we were interested in having in the exhibition.

At the meeting were the three members of Fast-uk, the Creative Director and the Programme Manager of folly. The meeting minutes were taken by the Programme Assistant and the Chief Executive of folly sat in briefly. We discussed what the aims and objectives and what the respective expectations and responsibilities of our organisations were and the potential compatibility of these. folly is a digital arts organisation committed to enabling new audiences to explore art through technology they work in Lancashire and Cumbria. In September 2005, folly had embarked on a project[79] to develop a new presentation space and media lab (due for completion in 2008) through the refurbishment of their premises within the Storey Creative Industry Centre (formerly the Storey Institute) in Lancaster. folly intended on hosting a series of exhibitions, events and activities under the brand 'f.city festival of digital culture'. They indicated the Fast-uk exhibition could act as an 'anchor' around which the other events could take place over a few weeks. The full festival programme would span the genres of media art, music and performance with

[79] The researcher and Cezanne Charles received a commission for an interactive virtual public art intervention as part of the Virtual Storey project. This is a fully interactive 3D model of the new plans for The Storey Creative Industry Centre produced by Squidsoup in association with the architects Mason Gillibrand. The model was produced with financial support from Lancaster City Council and Arts Council England North West and focuses on the newly designed public spaces and virtual public art interventions by a series of artists commissioned by Folly, Storey Gallery and Litfest. The virtual model was launched at folly on the 17th June 2004.

links to the community, educational and commercial sectors. This would take place in distributed venues across Lancaster.

Potential sites for the Fast-uk exhibition that were suggested were the Regal Cinema which was being forced to close after seventy years because of the opening of a new multiplex; or a group of historic buildings in the centre of Lancaster that were being redeveloped. This site was to provide one thousand five hundred square metres of new office space on the site of the old Council Housing Offices in Dalton Square. These new offices were for technology-based start-up businesses. The latter was of greater interest to us. If used for the exhibition this Dalton Square property would not yet be occupied. It was felt that if we were going to use a non-traditional exhibition venue we were more interested in this 'unmarked' space. The new purpose of these buildings for technology-based businesses also seemed more appropriate than an old cinema.

At the meeting the researcher disclosed the intention to use his involvement in the project as a means of gathering data for this research project. A presentation was made to clarify the aims and objectives of the research. This presentation was titled 'Perimeters, Boundaries and Borders'[80] marking a change back to the original title from the ACE grant working title of 'Perimeters, Boundaries and Dimensions'. This presentation included a 'wish list' of practitioners the researcher indicated would be desirable for the commissions for inclusion in the exhibition. These were: Driessens & Verstappen, Freedom of Creation, Human Beans, FutureFactories, sixteen*(makers), Justin Marshall, Ken Rinaldo, Thomas Heatherwick, Greg Lynn and Patricia Piccinini. The researcher also made folly staff aware of his research wiki that had a list of links to examples of work that were considered to fit the curatorial brief. This was acceptable and the potential nature of the partnership was discussed. We indicated there were line items in the budget for a project and outreach coordinator and a pr/marketing professional and asked if folly would be interested in taking on these project management roles. They were very

[80] The first work mentioned in Rosalind Krauss's 'Sculpture in the Expanded Field' is Perimeters/Pavilions/Decoys, 1978 by Mary Miss. This was stuck together with a statement made at the end of the Wachowski brothers' 1999 film 'The Matrix' where Keanu Reeves' character Neo calls up the machine world that controls an enslaved humanity and declares: "…I'm going to show these people what you don't want them to see. I'm going to show them a world without you, a world without rules and controls, without borders or boundaries, a world where anything is possible. Where we go from there, is a choice I leave to you." Ergo - 'Perimeters, Boundaries and Borders.'

interested as they were in the process of hiring additional staff to expand their research and consultancy work. This essentially meant that Fast-uk and folly would be co-presenting the exhibition with the roles of 'partner' and 'consultant' being blurred. It was not felt that this would pose any conflicts.

Within a week of this meeting we had been successful in being able to secure the Dalton Square building from Lancaster City Council (LCC) for the exhibition and had set a timeline that this should open by the 29th September. At this point we contacted ACE to confirm the new partnership with folly and moving the project to Lancaster. The Dalton Square building (CityLab) was to be ready by July and the entire building was to be available for us to use free of charge. We decided to take over the entire ground floor for ease of access for visitors and logistics for installation and security. As well as a series of new office spaces this included a central circulation spine and large breakout space (see shaded area of Figure 49).

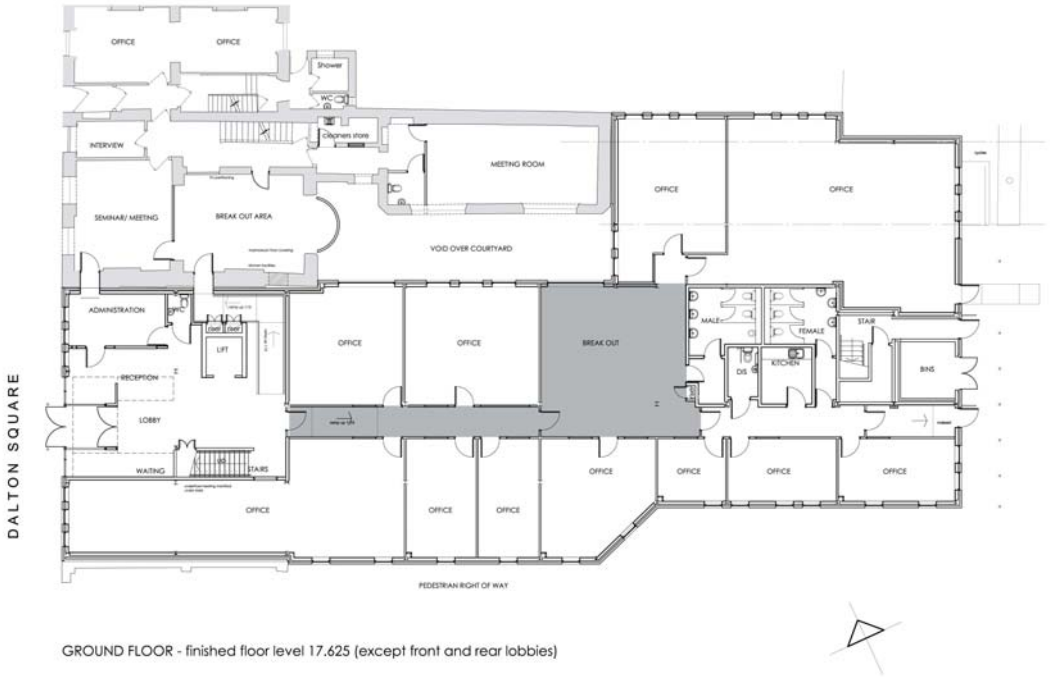

Figure 49: Ground floor plan of CityLab, Lancaster

There was also the option of using the lobby, and the large glazed wall facing onto the square at the front of the building (Figure 50). We determined the exhibition should be open for not less than two weeks, and no more than four as there were implications for the budget if we could not find volunteers to invigilate the space during opening times.

Figure 50: A rendering of the glazed wall facing onto Dalton Square at the front of CityLab in Lancaster

ACE were satisfied with the changes to the proposed project and made an initial payment of the grant to Fast-uk. A further payment would be payable on receipt of a satisfactory final report on completion of the project. folly approached us and asked us to consider using the f.city name on the project. Several variations were proposed but it was agreed to use 'Perimeters, Boundaries and Borders - an f.city exhibition from Fast-uk and folly'. This was to ensure consistent branding across the festival activities.

Fast-uk submitted an outline of the project budget and a draft consultant's brief and agreement to folly for consideration. The general nature of the consultancy was that Fast-uk wished to engage folly to undertake the project management of the 'Perimeters, Boundaries and Borders' exhibition including participating in the curation of the event and in securing additional funding as match to the grant from the Arts Council England. It was envisaged the project management would entail:

- Developing bids to secure additional project funding as match to the ACE grant
- Creating an evaluation plan for the exhibition, which will include various quantitative and qualitative measures
- Developing a communications plan, coordinating publicity and public relations activities, and serving as a point of contact for the exhibition
- Providing additional key exhibition/administrative support, including but not limited to:
    1. Being part of the selection panel
    2. Coordinating volunteers, gallery invigilators, etc.
    3. Answering questions and inquiries from artists and the public
    4. Handling co-organisational communications

5. Besides the general project coordination activities outlined above, folly was to devise and deliver strategies for developing and supporting audiences to participate in the exhibition.

Expected project outcomes were:

- An exhibition comprised of new commissions around the convergence of sculpture, architecture and product design as a result of the use of 3D computer technologies (selected by invitation) and an exhibition of existing works in this area (selected by an open call)
- A panel discussion and publication
- A series of workshops for practitioners (pending further funding)

These terms were acceptable and a signed agreement and first invoice was sent from folly to Fast-uk. Meanwhile project support from MIRIAD was confirmed and the three members of Fast-uk and folly's Programme Manager had a meeting in Lancaster to view the CityLab site. This was still a raw construction site with finish work not yet begun but the project team was excited by the potential of the space.

The researcher set up a project wiki - a collaborative website which could be directly edited by the members of the project team with access to it. This was used to keep track of information about the selection process for the commissions and the open call. The researcher posted links and information to those practitioners already identified as fitting the curatorial brief. For the exhibition 6 new works were to be commissioned at £2,500 each. In addition fees were available for the exhibition of 9 existing works at £500 each. The researcher circulated a draft of the open call to the project team for comment. This was made publicly available as a downloadable three page PDF with an additional one page equal opportunities monitoring form from the Fast-uk and folly websites. The text of the call was as follows:

> 'Perimeters, Boundaries and Borders'
> an f.city exhibition from Fast-uk and folly
>
> Call for entries
>
> 'Perimeters, Boundaries and Borders' is an exhibition of contemporary arts and design practice. It is especially concerned with object and spatially oriented disciplines, the use of digital technologies and the convergence of sculpture, product design and architecture.

> This exhibition will bring emerging and existing contemporary practitioners and technologies into the public arena and help to make cutting edge developments in art and technology more accessible. 'Perimeters, Boundaries and Borders' will be held from 29 September - 21 October 2006 at venues across Lancaster city centre in the North West of England. The main exhibition space will be the new CityLab development in Dalton Square.
>
> The aim of this exhibition is to present the very latest examples of work that blur the conventional boundaries of arts and design practice through the use of technology. This call for entries is for existing works which explore these creative perimeters, including but not limited to: computer-designed or manufactured objects and environments, visual and audio installations, pervasive and locative interactive pieces, games and game installations and 3D net-based works. Fees for the presentation of existing works are £500. There may be additional funds for travel and accommodation of selected artists.

There were instructions on how to apply, information on Fast-uk and folly and an application form. The deadline for submissions was by 10am, 26th May, 2006. A news release announcing the festival and call was distributed. folly made the call available through its electronic distribution list and newsletter and placed it on the ArtsJobs mailing list. The call also went out to all recipients of MIRIAD's electronic mailing list. The researcher sent the call to all his personal contacts and the respondents of the survey of international practitioners he had conducted (see section 4.3). The call was also sent to various university art, architecture and product design departments. It was also posted to online lists. In addition the researcher sent the call to many blogs[81].

Practitioner	Url	Rank
Driessens & Verstappen	http://www.xs4all.nl/~notnot/	1st choice
FutureFactories	http://www.futurefactories.com/	2nd choice
Patricia Piccinini	http://www.patriciapiccinini.net/	3rd choice
Human Beans	http://www.humanbeans.net/	4th equal
NIO Architecten	http://www.nio.nl/	4th equal
Theo Jansen	http://www.strandbeest.com/	5th equal
Torolab	http://www.torolab.co.nr/	5th equal
Chris Bosse	http://www.chrisbosse.de/	5th equal

Table 13: Practitioners selected for commissions

[81] e.g. http://www.core77.com/blog/, http://blog.wired.com/sterling/, http://tecfa.unige.ch/perso/staf/nova/blog/, http://www.guerrilla-innovation.com/, http://www.we-make-money-not-art.com/, http://www.artnode.org/, http://www.artificial.dk/, http://www.virtueelplatform.nl/

The curatorial team (Brown, Charles and Marshall for Fast-uk; the Creative Director and Programme Manager for folly) each selected their choices for the commissions by means of the project wiki that resulted in a shortlist of the top eight practitioners as shown in Table 13. The first five practitioners had been on the list initially presented by the researcher. Theo Jansen had been proposed by folly's Creative Director, Torolab by folly's Programme Manager and Chris Bosse by the researcher. Invitations were sent out by email to the top six choices for commissions with Torolab and Chris Bosse held as reserves:

> I represent the curatorial team putting together a forthcoming exhibition taking place this autumn in Lancaster in the North West of England. Entitled 'Perimeters, Boundaries & Borders', it is an exhibition of contemporary art and design practice that is concerned with object and spatially oriented disciplines, the use of digital technologies and the convergence of sculpture, product design and architecture.
>
> This exhibition will bring emerging and existing contemporary practitioners and technologies into the public arena and help to make cutting edge developments in art and technology more accessible. The show will be held from 29 September - 21 October 2006 at venues across Lancaster, the main exhibition space being the ground floor of the new CityLab development in Dalton Square. There will be six principal artists[82].
>
> The aim of this exhibition is to present the examples of work that blur the conventional boundaries of art and design practice through the use of technology. The exhibition is international in scope with artists and designers invited from Australia, Germany, Mexico, Netherlands as well as the United Kingdom.
>
> We would like to invite you to participate in this exhibition and present either a specially commissioned work/s or more recent work/s that has not previously been shown in the UK. If you would like to know more, I would be happy to answer any questions you may have. I look forward to hearing from you and hope we can work together on this exciting project.

The initial response from the first five practitioners contacted was positive. Extra information was requested by these practitioners or their representatives. There was no response from Theo Jansen. A request was made that these practitioners should indicate what they would like to do for the exhibition by 30th May. We subsequently received notice that Patricia Piccinini would not be

[82] This should have read 'practitioners'.

able to participate and Driessens & Verstappen withdrew. Therefore Torolab and Chris Bosse were invited to participate.

Meantime the researcher had been contacting various technology companies requesting sponsorship or in-kind support for the exhibition (for example Genometri, Materialise, Rhinoceros, 3D Systems, ZCorp, Laserlines and Kartell). A salesperson at 3D Systems indicated they may be able to bring a machine but they wanted a 20 minute slot in the panel discussion in return. We declined. We received a positive response from the Managing Art Director at Materialise .MGX who agreed to lend five rapid manufactured products for the exhibition. We either had no response or a rejection from the other companies.

Applicant	Y/N	P1	P2	P3	P4	P5	Total	Rank
Gavin Baily	Yes	3	1	2	2	2	10	4=
Practitioner 1	No							
Practitioner 2	Yes	2	1	1	2	1	7	7=
Simon Blackmore	Yes	2	2	1	1	3	9	5
Brit Bunkley	Yes	2	1	1	2	1	7	7=
Practitioner 3	No							
Practitioner 4	No							
Practitioner 5	No							
Practitioner 6	Yes	3	2	1	1	3	10	4=
Practitioner 7	Yes	2	1	1	1	2	7	7=
Practitioner 8	No							
Simon Husslein	Yes	3	2	3	2	1	11	3
Practitioner 9	No							
Practitioner 10	No							
Practitioner 11	No							
Practitioner 12	No							
Practitioner 13	No							
Practitioner 14	No							
Practitioner 15	Yes	2	1	1	2	2	8	6=
Practitioner 16	No							
Tavs Jorgensen	Yes	2	2	3	3	3	13	2=
Practitioner 17	Yes	1	1	2	2	1	7	7=
Practitioner 18	No							
Practitioner 19	No							
Practitioner 20	No							
Practitioner 21	No							
Practitioner 22	No							
Aoife Ludlow	Yes	2	2	2	2	2	10	4=
Practitioner 23	No							
Justin Marshall	Yes	3	3	3	3	3	15	1
Geoffrey Mann	Yes	2	2	1	2	3	10	4=
Practitioner 24	No							
Practitioner 25	No							
Practitioner 26	No							
Practitioner 27	No							
Practitioner 28	No							
Practitioner 29	No							
Practitioner 30	No							
Practitioner 31	No							
Masaru Tabei & Yasuno Miyauchi	Yes	1	2	1	1	2	7	7=
Practitioner 32	No							
Practitioner 33	No							
Practitioner 34	No							
Practitioner 35	Yes	1	1	2	2	2	8	6=
Ben Woodeson	Yes	2	2	3	3	3	13	2=
Practitioner 36	No							

Table 14: Curatorial panel process results

We received forty-six submissions by the due date of the open call. A curatorial meeting was held in Lancaster to select from the open call applications and to review the commission proposals. First the panel viewed the complete documentation submitted by the applicants to gain an overview of the field. Second the panel viewed the documentation again and discussed the merits of the work. At this point each panel member made a decision to consider the individual applicant further or not by a yes or no vote with the majority opinion being considered (see Table 14). If the decision was 'yes' each panel member assigned a score of 3, 2 or 1 (3 being more in favour of the work being included). If the majority opinion was 'no' the application was no longer considered. All applications that were scored were then ranked highest score to lowest. The panel arrived at a shortlist of nine applicants to be considered for support based on the submission's relevance to the exhibition brief, cost, and feasibility. There were several types of work which were similar to each other. In these cases the panel discussed these and arrived at a decision based on which work would contribute to the overall diversity of the exhibition and encourage different types of interaction with the audience.

These ten sets of practitioners[83] were approached and informed that their submissions had been successful. The others were informed they had not and their documentation was returned. Theo Jansen and Chris Bosse had not responded to our invitations for commissions from them. Since we still only had 3 positive responses for the commissions the curatorial team decided to drop one of the £2,500 commissions to enable us to have more resources to support the open call works with additional funding for shipping and expenses for the practitioners to install their work. Torolab had responded to our invitation but we were still waiting for a proposal from them. Negotiations took place amongst the curatorial team over who to invite for the remaining commission. It was felt that architects were underrepresented in the selection for the exhibition. The researcher had met and been impressed with the work of Usman Haque and proposed that he might have something that was appropriate. He was subsequently invited and proposed a suitable work for

[83] Simon Blackmore (UK), Brit Bunkley(NZ), Simon Husslein (D), Tavs Jorgensen (DK), Geoffrey Mann (UK), Masaru Tabei & Yasuno Miyauchi (JP), Ben Woodeson (UK), Gavin Baily & Tom Corby (UK), Aoife Ludlow (I), Justin Marshall (UK).

which he was commissioned. We still had heard nothing from Torolab. A decision was made to drop their commission and repurpose these funds for the panel discussion now conceived as a symposium to take place on the day of the exhibition opening. This made most sense since many of the practitioners would be in Lancaster anyway. With all the selections for the exhibition completed contracts were sent out to be signed by both the participants and Fast-uk.

4.5 A public exhibition and symposium

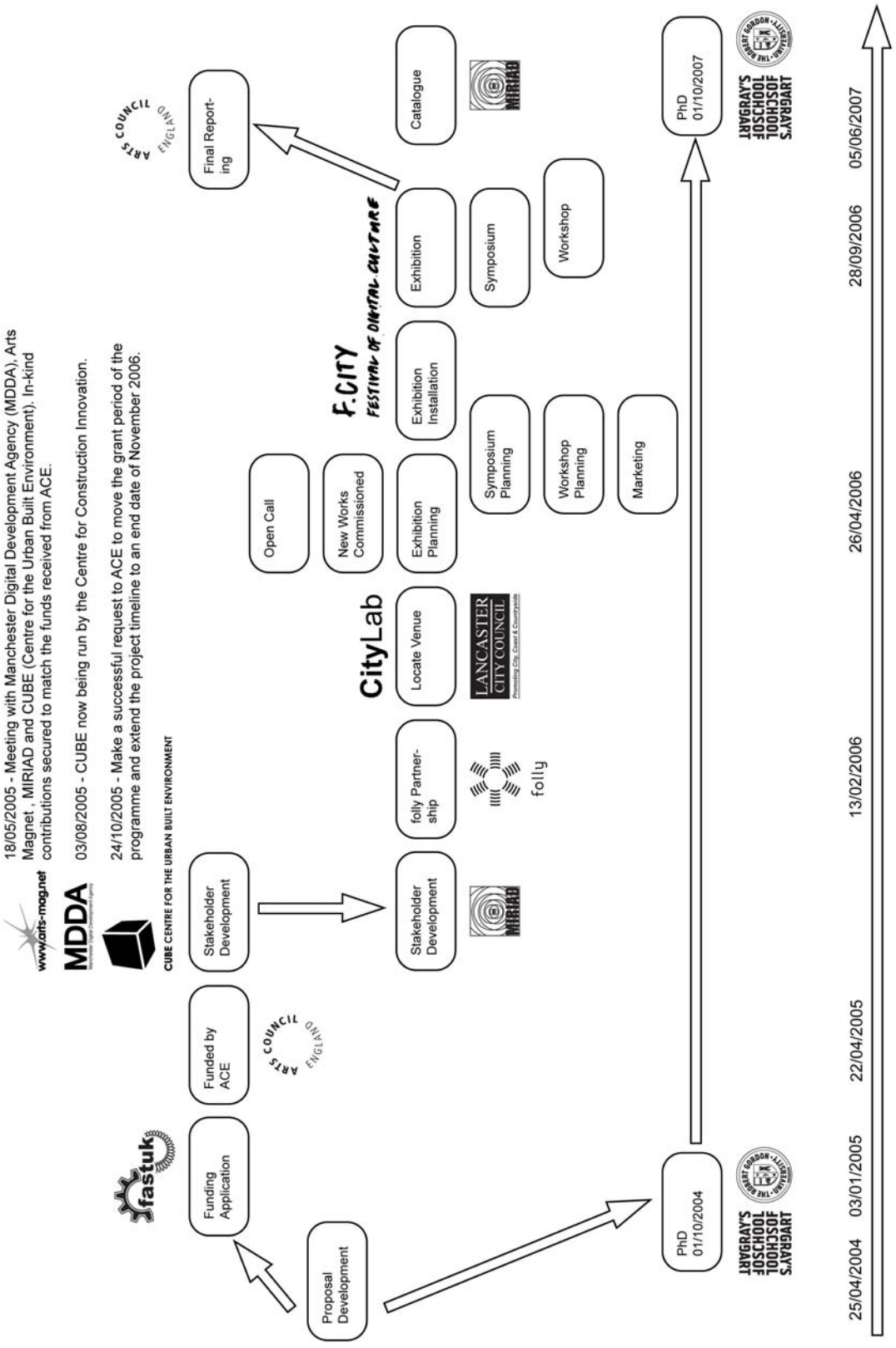

Figure 51: Graphical timeline of key milestones in curatorial process

Date	Activity
25/04/2004	Researcher sets out some objectives for a themed exhibition.
06/07/2004	Researcher develops proposal for an exhibition of works 'not limited by genre'.
01/10/2004	Researcher begins current research project.
03/01/2005	Submit application for £36,600 to Arts Council England's (ACE).
22/04/2005	Offer of £30,000 from ACE.
25/04/2005	Invite Lancaster-based, not-for-profit digital arts organisation folly to become a project partner.
04/05/2005	Financial commitment from Manchester Institute for Research and Innovation in Art and Design (MIRIAD).
18/05/2005	Meeting with Manchester Digital Development Agency (MDDA), Arts Magnet[84], MIRIAD and CUBE (Centre for the Urban Built Environment). In-kind contributions secured to match the funds received from ACE.
03/08/2005	CUBE now being run by the Centre for Construction Innovation.
24/10/2005	Make a request to ACE to move the grant period of the programme and extend the project timeline to an end date of November 2006.
13/02/2006	Meeting with folly to discuss moving exhibition to Lancaster.
21/02/2006	Secure the Dalton Square building (CityLab) from Lancaster City Council for the exhibition and set a timeline that this should open by the 29th September.
22/02/2006	Confirm the new partnership with folly with ACE.
09/03/2006	Funding received from ACE.
11/03/2006	Agree to use title 'Perimeters, Boundaries and Borders - an f.city exhibition from Fast-uk and folly' to ensure consistent branding across folly's festival activities.
20/03/2006	Submit an outline of the project budget and a draft consultant's brief and agreement to folly for consideration.
06/04/2006	Project support confirmed from MIRIAD.
20/04/2006	View the CityLab site.
21/04/2006	Set up a project wiki - a collaborative website which can be directly edited by the members of the project team with access to it.
26/04/2006	Open call for works made publicly available.
03/05/2006	Open call press release issued.
08/05/2006	Selected practitioners for new works short-listed and invited.
12/05/2006	Initial responses from invited practitioners positive.
19/05/2006	Invited practitioner withdraws.
23/05/2006	Invited practitioner withdraws.
26/05/2006	Deadline for submissions from open call – 46 received.
30/05/2006	Curatorial panel selects works from open call.
08/06/2006	Selected practitioners informed that their submissions have been successful.
14/06/2006	Secure use of an appropriate IT suite in St. Martins College to conduct the Open Source 3D workshop.

[84] A now-defunct Manchester-based digital development agency for the arts.

27/06/2006	Additional practitioners for new works invited.
03/07/2006	Managing Art Director at Materialise .MGX agrees to lend five rapid manufactured products for the exhibition.
01/08/2006	Exhibition press releases issued.
08/08/2006	First a-n magazine advert.
14/08/2006	Additional funding from MIRIAD to be used to produce an exhibition catalogue.
17/08/2006	Technical plan for exhibition.
17/08/2006	Decide to move .MGX products to 2nd venue: Arteria for publicity and cost-saving reasons.
04/09/2006	Second a-n magazine advert.
04/09/2006	Technical installation budget for exhibition.
06/09/2006	Final review of the venue in order to allocate specific spaces to those individual works that did not have particular needs.
07/09/2006	All signed contracts from practitioners received.
07/09/2006	Confirm Dr. Paul Rodgers as symposium keynote speaker.
14/09/2006	Begin installing exhibition.
22/09/2006	Symposium details confirmed.
28/09/2006	Symposium and exhibition opening.
17/10/2006	Open Source 3D workshop.
21/10/2006	Exhibition closes.
16/05/2007	Final report submitted to ACE.
05/06/2007	Final payment made by ACE.

Table 15: List of key milestones in curatorial process

On the initial visit to CityLab the space had been a raw shell. When the exhibition team was finally able to gain access to the space as it was nearing completion we were all shocked at the transformation that had taken place in the space. However, it had been finished with the needs of technology-based start-up businesses as potential tenants in mind. This had been achieved in a neutral and corporate manner with blue carpeting and magnolia walls. Also many of the walls that had been earmarked for the display of works had radiators installed on them and all the office spaces had electrical trunking surface-mounted on them. We immediately knew that this was going to raise issues with some of the participating practitioners. However, we acknowledged the site was never going to be a conventional gallery space and this presented opportunities as well as challenges.

One of the main opportunities of this was all the individual office spaces had glazed front walls that provided the possibility of having individual spaces for particular projects whilst also affording visual access and connection to other works. Some of the polysterene ceiling panels were removed and temporary

coloured lighting was installed in the main CityLab space (particularly in the central spine and breakout space with blue gels over the existing fluorescent light fittings). This helped to take away from the corporate feel of the space. However, the fire officer was less than happy with the lux levels in the circulation areas and a compromise position had to be reached by removing some of these.

The .MGX products were moved two minutes walk away across Dalton Square to Arteria - a small craft-based gallery space. This freed up some of the budget and removed some of the worries we had over security for these fragile rapid-manufactured objects. In addition since the entire front window of Arteria was given over to these objects we saw the potential of this satellite site as an opportunity to drive passersby to the main exhibition venue. Also, during the exhibition the workshop: 'Grow Your Own Media Lab in 3D'[85] was held at St Martin's College in Lancaster for 12 people[86].

4.5.1 New work commissioned

For the exhibition four new works were commissioned. The practitioners were contacted and invited to contribute to an exhibition of contemporary art and design practice that is concerned with object and spatially oriented disciplines, the use of digital technologies and the convergence of sculpture, product design and architecture. They were informed the aim of the exhibition was to present examples of work that blur the conventional boundaries of art and design practice through the use of technology. It was indicated that either a specially commissioned work or a more recent work that had not been shown in the UK previously was eligible for inclusion in the exhibition. Fees of £2,500 were paid to each of the selected practitioners. Of the four sets of commissioned practitioners two have backgrounds in design practice and two have backgrounds in architectural practice.

[85] With artist, free-software developer, educator and media-theorist Julian Oliver. http://www.julianoliver.com/
[86] On 17/10/2006.

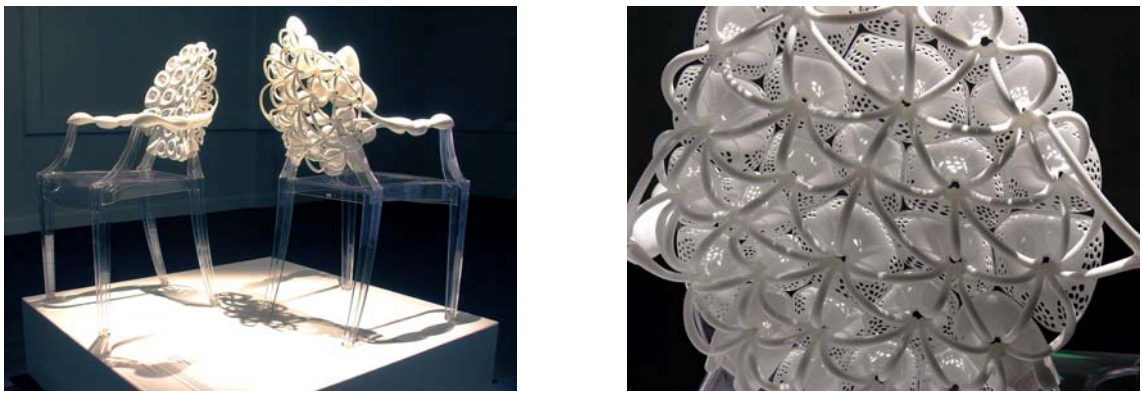

Figure 52: 'Holy Ghost', 2006. FutureFactories

Commission 1. 'Holy Ghost' (2006) by Lincolnshire-based FutureFactories[87] explores notions of metamorphosis, symbiosis and parasitism. In this work Lionel T. Dean continues the FutureFactories[88] theme of organic growth with a design that is in a constant state of evolution. The back and arms of an iconic chair (Louis Ghost designed by Philippe Starck and produced by Kartell) have been replaced to create a new reading of both an everyday object and an iconic object of desire. Dean has developed these new forms algorithmically and output two 'hard copies' of the design using SLS® technology. In the exhibition alongside this pair of chairs was a suspended Perspex screen onto which the rule-based, parametric metamorphosis of the chair design was rear-projected (life-sized and happening in real-time).

Figure 53: 'Holy Ghost' (left) and 'Holy Ghost Sketch' (right), 2006. FutureFactories

This work was the subject of the largest amount of negotiation between Fast-uk and folly. This was the one work in the exhibition that Fast-uk was committed to having and that folly was not convinced by. The rough sketch (Figure 53,

[87] http://www.futurefactories.com

[88] FutureFactories is a digital manufacturing concept for the mass individualisation of products. Dean is Designer in Residence at Huddersfield University.

right) submitted by this practitioner with the initial proposal was partially the cause of this. By its nature this work cannot be accurately represented until it has been completed.

'Holy Ghost' was the work in the exhibition that received the most attention from the press and was mentioned at least eight times. This work was also most cited (31%) by the other practitioners that were interviewed as the strongest work in the exhibition. One visitor in the audience survey indicated that 'Holy Ghost' was the thing they liked most in the exhibition. This work received a considerable amount of in-kind support from the Newbury-based rapid prototyping company 3T RPD Ltd. The price of the sintered parts was more than the funding available. This work is now being used as a case study[89] for promotional purposes by this company. Since the exhibition 'Holy Ghost' was shown in the exhibition 'Digitalability' at the Designmai Forum, Mitte, Berlin, May 12 – May 20, 2007[90].

Commission 2. 'What's Cooking Grandma?' (2006) by London-based Human Beans[91] aims to popularise a new genre of documentary video clip - the 'Grandma Recipe'. Human Beans is collaboration between advertising creative and designer Mickael Charbonnel and design strategist Chris Vanstone. Human Beans make fictional products by hacking commercial culture and design new services by working with real people. Their work is disseminated through spam, media, on shop shelves and in exhibitions. They assert that technologies which were once bleeding-edge and the domain of professionals are now commonplace and affordable.

[89] http://www.3trpd.co.uk/pdf/case-studies/Holy%20Ghost%20Chair.pdf
[90] http://www.designmai.de/cgi-bin/designmai2007.pl/Digitalability/Essay
[91] http://www.humanbeans.net and http://www.whatscookinggrandma.net

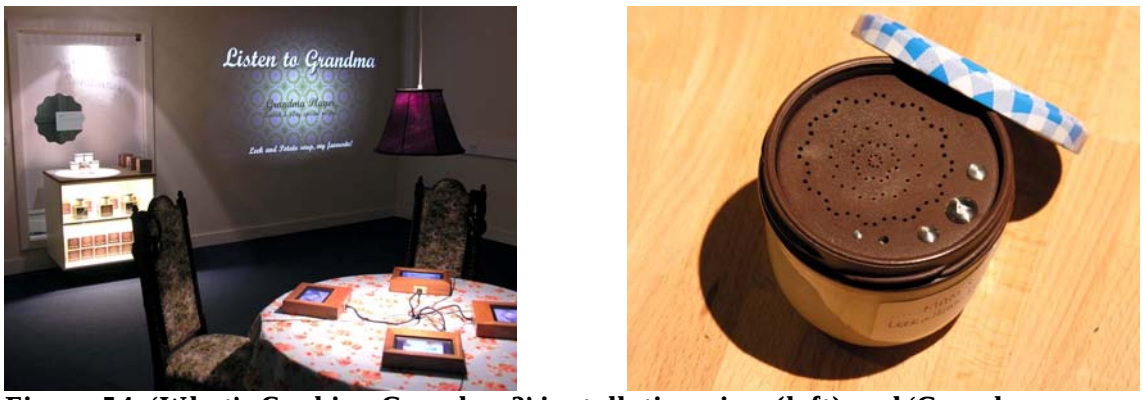

Figure 54: 'What's Cooking Grandma?' installation view (left) and 'Grandma Player' (right) 2006. Human Beans

Human Beans claim that this democratisation of technology is fuelling the development of new forms of literacy. Inspired by this they want to catalyse the mass documentation of Grandmothers' cooking their own special recipes in their own kitchens. To get things started they made recordings of Grandmothers living in the Lancaster area and uploaded them to YouTube. Shown alongside these films in the exhibition were non-functioning prototypes of 'Grandma Players' (Figure 54, right) - a new kitchen appliance (based on a modified jam jar). These were designed to record your Grandma's instructions and the sound of her cooking - so you can play her back in your own kitchen and cook along with Grandma.

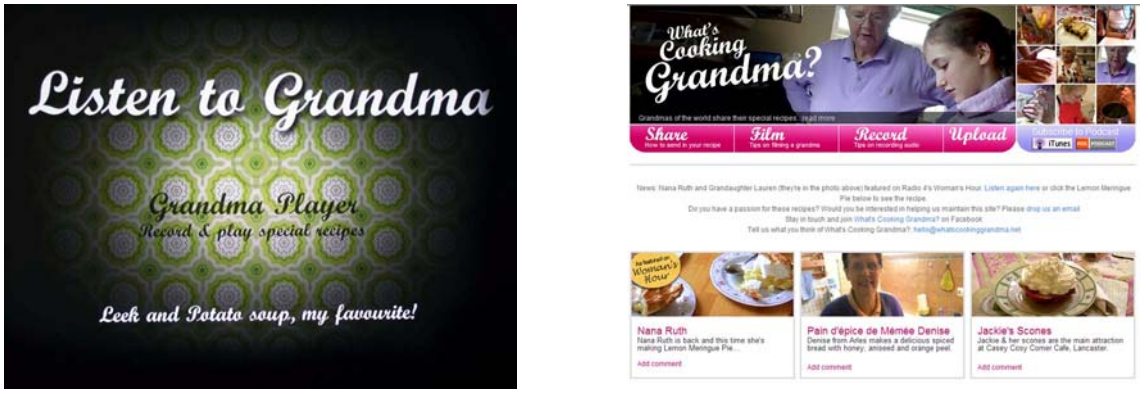

Figure 55: 'What's Cooking Grandma?' (left) and website (right) 2006. Human Beans

'What's Cooking Grandma?' was the fourth (equal) most-referenced piece by the press from the exhibition. However, this work was featured in possibly the highest profile references of all works as separate segments on CBC/Radio-Canada's 'Freestyle' and Radio 4's 'Woman's Hour'. This work was the one work in the exhibition that most surprised the other participating practitioners (33%)

that were interviewed. Human Beans were the least anticipated (50%) participants in the exhibition for the same group. 'What's Cooking Grandma?' was indicated as most liked by two visitors and tied for the second most popular work in the exhibition in the audience survey. Human Beans and 'What's Cooking Grandma?' were both cited as the most surprising practitioners and the strongest work in the exhibition by folly. Since the exhibition 'What's Cooking Grandma?' continues to expand online and was featured in the exhibition 'My Own Private Reality' selected by Sabine Himmelsbach and Sarah Cook at the Edith Russ Site for Media Art in Oldenbourg, Germany. May 12 - July 1, 2007[92].

Commission 3. 'Watermark' (2006) by Rotterdam-based NIO Architecten[93] is a series of prototype façade panels for a leisure park and a cluster of buildings for the city of Middelburg in the Netherlands. Architects Joan Almekinders, Radek Brunecky, Sean Matsumoto and Maurice Nio developed a set of rules related to building materials where circles were to be expressed in several ways (small round perforations in a steel plate, patterns cast in concrete, big round constructional elements, etc.). For this exhibition they presented ten rapid prototyped panels of potential building materials to be used within the project and a screen-based, slide presentation showing the sources drawn on for their creation and renderings of how the panels would look once tiled. The architects stated the panels embody various moods and the characteristics of water: desire-whirl, arousal-cohesion, thrill-humidity, satisfaction-drop, curiosity-drifting, relaxation-rain, joy-floating, excitement-boiling, welcoming-wave and anticipation-ripple.

Figure 56: 'Watermark', 2006. NIO Architecten

[92] http://myownprivatereality.wordpress.com/
[93] http://www.nio.nl

The architects initially proposed these panels be shown in front of a wall painted red and gray. To prevent painting the space or building a temporary wall in the exhibition they were shown lit by a series of spotlights with red filters. The architects were satisfied with this change. However, the architects were far from satisfied they were not expressly invited to the exhibition opening and informed the partners of this in their self-evaluation report at the end of the project. It had been assumed that since there was no additional funding available to bring the architects to Lancaster from Rotterdam for this event they would not want to be out-of-pocket. Although they had been made aware of the opening dates they were not sent an invitation. This was a regrettable mistake.

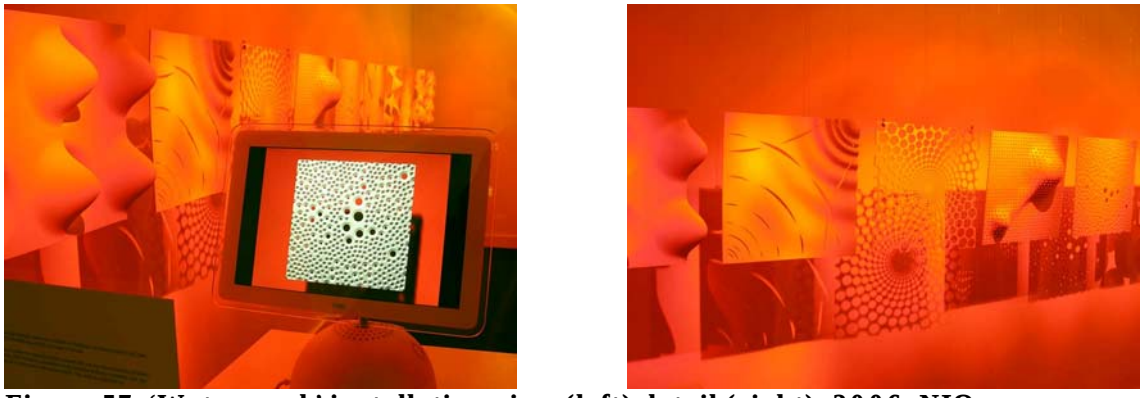

Figure 57: 'Watermark' installation view (left) detail (right), 2006. NIO Architecten

'Watermark' was the only work in the exhibition not to be referenced by the press. From the audience surveys received one visitor indicated that 'Watermark' was their most popular work in the exhibition. It was indicated as one of the works that least fit folly's artistic vision in the exhibition. NIO had been selected based on their 'Amazing Whale Jaw' project for Hoofddorp and the curatorial team had expected the work proposed for the exhibition might be a model of something similar. They would have liked to see some designs for buildings not just designs for surfaces. This work received a considerable amount of in-kind support from the Heerhugowaard-based rapid prototyping company Gravotech-Holland.

Commission 4. 'Wifi Camera Obscura' (2006) by Adam Somlai-Fischer, Bengt Sjölén and Usman Haque consisted of two antennas fabricated from empty cans of wasabi-covered peas. These were mounted on mechanised tripods in CityLab and scanned the space for wireless network signals. Real-time images of these

were generated and presented on a wall-mounted screen in the exhibition space as constantly updating images. Adam Somlai-Fischer[94] is a Stockholm-based architect and interaction researcher. Bengt Sjölén[95] is a Swedish independent game technology researcher. London-based architect and artist Usman Haque[96] specialises in designing interactive architectural systems and is interested in the ways that people relate to each other and to their surrounding space.

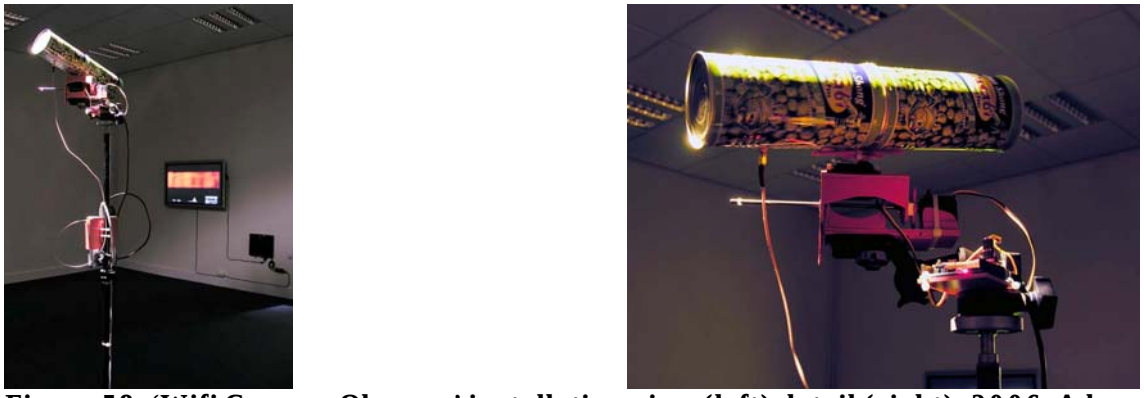

Figure 58: 'Wifi Camera Obscura' installation view (left) detail (right), 2006. Adam Somlai-Fischer, Bengt Sjölén and Usman Haque

'Wifi Camera Obscura' tied for the third most-referenced piece by the press from the exhibition and was mentioned at least four times. This work was also most cited (37.5%) by the other practitioners that were interviewed as the weakest work in the exhibition. It was indicated one of the most surprising works in the exhibition by folly. From the feedback received about this work the general feeling is that it was a clever piece but the relationship between the wireless network signals and the images produced were not explicit. Most people wanted to know more about what the antennas were actually doing and how to 'read' the resulting images. A prototype of this work was shown at The 'Art + Communication' festival, organised by RIXC in Riga, Latvia. August 24 - August 26, 2006[97].

4.5.2 Works selected from open call

Works were contributed by ten sets of practitioners. These practitioners responded to the open call for participation that was made publicly available via the Fast-uk and folly websites and was posted on electronic distribution lists

[94] http://www.aether.hu
[95] http://www.automata.se
[96] http://www.haque.co.uk
[97] http://rixc.lv/waves/en/home.html

and in newsletters and on blogs. The researcher also sent the call to his personal contacts and the respondents of the survey of international practitioners that had previously been conducted. The call was also sent to various university art, architecture and product design departments. Fees for the presentation of existing works were £500. Additional funds for travel, accommodation and shipping for selected practitioners was also made available as needed.

Open Call 1. 'Cyclone.soc' (2006) by London-based Gavin Baily and Tom Corby[98] is a projected installation that maps text from political and religious online newsgroup forums onto the isobars of hurricanes. Baily's work has focused on developing conjunctions of software-based visualisation and the data traces of social processes. Corby is interested in the development of innovative concepts, and processes that relocate the digital image within wider aesthetic and critical frameworks.

Figure 59: 'Cyclone.soc', 2006. Gavin Baily and Tom Corby

This is a navigable project that gives the user the ability to zoom in or out and drag the projected data to focus in on and read the newsgroup text. The project uses edited data from different storms derived from publicly available satellite forecasting for the Eastern coast of the United States. The application runs on Windows platforms with a 3D Graphics card supporting OpenGL. Concerns about this work were expressed at the curatorial panel that this work did not fit with the object and spatially oriented disciplines or the convergence of sculpture, product design and architecture sufficiently to warrant its inclusion in the exhibition. Originally, it was to be presented as a flat projection.

[98] http://www.reconnoitre.net

However, the artists were approached and asked if they would consider showing the work projected across the end of a long room in CityLab. It was also proposed that a sensor be installed to make the work respond to the audience in the space rather than by using a computer mouse as it had been shown before. The artists responded positively to these suggestions. In the end because of lack of time the work was presented with the mouse on top of the plinth containing the data projector. It was however, projected across three walls, the floor and ceiling so it could be 'entered' by the audience. This work was installed opposite one of the antennas of the 'Wifi Camera Obscura' so its wireless network connection could be scanned for signals.

'Cyclone.soc' received the second highest amount of attention from the press and was mentioned at least seven times. This work was also most cited (11%) by the visitors in the audience survey as the thing they liked most in the exhibition. None of the participating practitioners that were interviewed were surprised by its inclusion in the exhibition. Since the exhibition the researcher has contributed photographs of 'Cyclone.soc' to the forthcoming book by Richard Colson 'The Fundamentals of Digital Art' by Ava Publishing (16/10/2007).

Open Call 2. 'Light Sensitive Disk (LSD) Drive' (2006) by Manchester-based Simon Blackmore[99] is a reconfigured product that is able to interpret lost data from degraded compact discs that have been left outside and exposed to the elements. Blackmore has been reinventing the function or image of culturally iconic objects to make sculptures, including converting a caravan into a gallery, making audio laptops from logs and turning a pole lathe into a musical instrument.

[99] http://www.simonblackmore.net

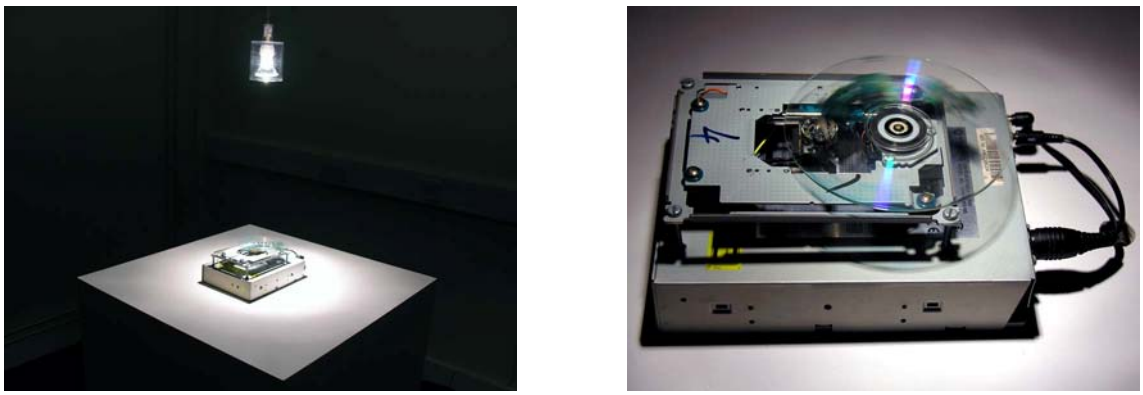

Figure 60: 'Light Sensitive Disk (LSD) Drive' installation view (left) detail (right), 2006. Simon Blackmore

Blackmore has taken a CD drive from an old computer and made it function again using hand coded microcontrollers. The laser that normally reads the data has been replaced by a light sensor that detects changes in light levels passing through the disc. This information is sent to a computer as midi data and processed in the Open Source software, SuperCollider[100] to sequence the playback of live recordings of the space the work is exhibited in.

'LSD Drive' was the fifth most-referenced piece by the press in a five-way tie with two references. 'LSD Drive' was originally commissioned by folly for the exhibition 'Instrument'[101] curated by Colin Fallows and Drew Hemment at The Museum of Science and Industry in Manchester as part of the Futuresonic Urban Festival of Electronic Music and Arts, Manchester. July 20 - July 29, 2006[102]. It was shown in a different configuration for 'PBB'.

Open Call 3. 'Ibuki – Presence in a Sigh' (2006) by Gifu-based Masaru Tabei and Yasuno Miyauchi[103] is a pebble-covered object which transfers an ambient, water-like digital audio sound track through the body by conducting the sound to the inner ear through the bones of the skull. The user puts his or her chin on top of the object, and the vibration is transmitted through the jaw and 'heard'. The sound is played by a CD player through an amplifier and then converted into vibrations by an actuator which is connected to the top of the object.

[100] http://supercollider.sourceforge.net/
[101] http://10.futuresonic.com/urban_play/instrument/
[102] http://10.futuresonic.com/
[103] http://www.hyougensya.com

Figure 61: 'Ibuki – Presence in a Sigh', 2006. Masaru Tabei and Yasuno Miyauchi

Masaru Tabei and Yasuno Miyauchi are studying at the Institute of Advanced Media Art and Science (IAMAS), Japan. The artists intended that use of smooth pebbles and the shape of the object would invite visitors to embrace the object and to rest their chin on it. This work had previously been shown with the actuator inside a polystyrene form wrapped in a coil of rope (Figure 62, right).

Figure 62: 'Ibuki – Presence in a Sigh', 2006 (left) and 'Ibuki – Presence in a Sigh', 2005 (right). Masaru Tabei and Yasuno Miyauchi

When the artists were contacted and informed their work had been selected for the exhibition the expense of shipping this object from Japan to Lancaster became an issue. The artists proposed they make a new 'Ibuki' object – the pebble-covered foam form that was shown in the exhibition. They also sent drawings for a plinth to be made to accommodate the CD player, amplifier and the actuator and specifications for the lighting conditions they required. This was all completed as directed by the technical staff at folly. However when all of these components were brought together in CityLab the piece did not work exactly as described by the artists. The sound was faintly audible even when not in contact with the object. Adjustments were made but this could not be resolved. It is not clear what aspect of the construction was at fault.

Some visitors to the exhibition seemed to be annoyed by this piece because it was never obvious if the piece was working properly or not. It never lived up to the expectation built up for it in the exhibition guide and label text. 'Ibuki' was referenced by the press in at least one article. It was also cited as one of the works in the exhibition that least fit the artistic vision of folly because of the issues mentioned above.

Open Call 4. 'Flight – Take Off' (2006) by London-based Geoffrey Mann[104] materialises the immaterial into solid objects. Mann works as product artist, digital consultant and lecturer and his current research focuses on creative ways of 'humanising' the processes of digital production.

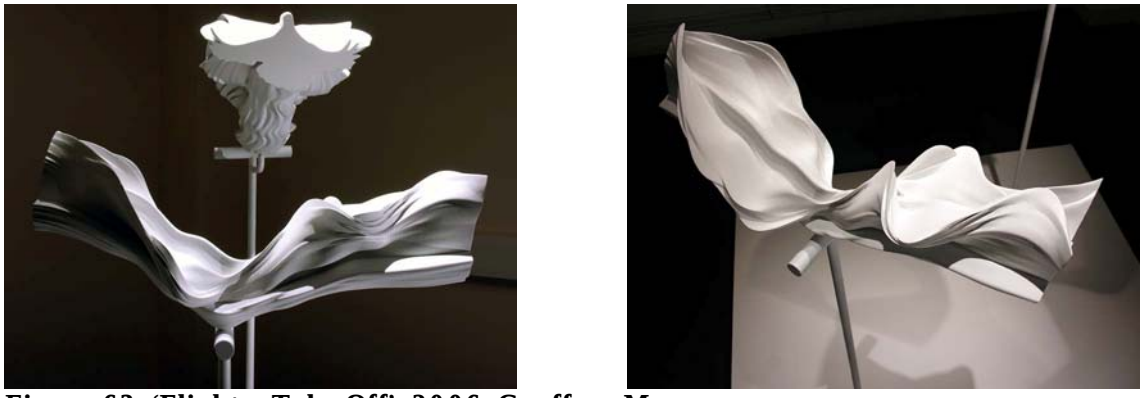

Figure 63: 'Flight – Take Off', 2006. Geoffrey Mann

This pair of objects depicts the trace-echo of the flight path of a bird. The trajectory of the bird is captured frame-by-frame by StroMotion™ technology to illustrate the movement through five seconds each. This is based on stroboscoping (a means of analysing rapid movement) so the bird is perceived as a series of static images along its trajectory. The three-dimensional form is lofted[105] from this sequence of animated frames which allows the form to become materialised through a 3D printing process.

'Flight – Take Off' was indicated by two visitors as the most liked thing about the exhibition and was therefore tied with 'What's Cooking Grandma?' as the second most popular work in the audience survey. This work was also the fifth most-referenced piece by the press in a five-way tie with at least two references to it.

[104] http://www.mrmann.co.uk
[105] 3D objects are 'lofted' by extruding 2D shapes along an axis or path.

Open Call 5. 'Coded Ornament' (2006) by Falmouth-based Justin Marshall[106] consists of plaster mouldings that integrate digital design technologies with traditional manufacturing skills developed through collaboration with Hayles & Howe (a manufacturer of architectural ornamental plasterwork). Marshall's practice spans sculpture, installation and design. He is Research Fellow in 3D digital production at University College, Falmouth.

Figure 64: 'Morse', 2006. Justin Marshall

Two works were included in the exhibition. 'Morse' (Figure 64) makes reference to the binary nature of digital information. The work is based on two plaster units that reference the 'dot' and 'dash' of Morse code[107]. The moulds for these units were developed in CAD from profiles based on text and were CNC milled. The message which is coded in the piece reads "What hath God wrought"[108]. 'Penrose Strapping 1' (Figure 65) is a contemporary example of traditional architectural strapwork arranged as scrolls, arabesques, and loops installed on a temporary wall constructed for the exhibition. A Penrose aperiodic tiling system (discovered by Roger Penrose in 1973) was used as the basis for this plaster design. This type of tiling allows complex non-repeating tessellations to be produced from only two units. The system also allows an infinite variety of different designs to be produced from just these basic units.

[106] http://www.justinmarshall.co.uk

[107] A method for transmitting telegraphic information, using standardised sequences of short (dot) and long (dash) elements to represent the letters of a message.

[108] The text of the first telegraph message ever transmitted by Samuel F.B. Morse on May 24, 1844. The message is a Biblical quotation from Numbers 23:23.

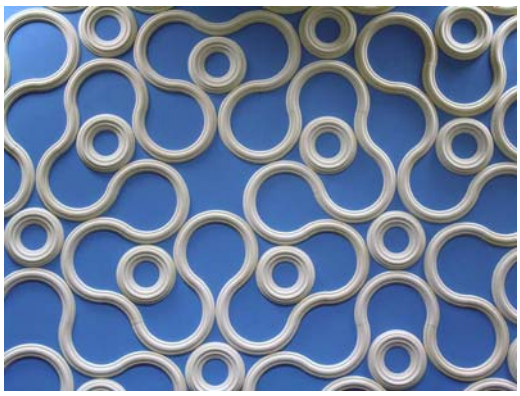

Figure 65: 'Penrose Strapping 1', 2006. Justin Marshall

'Coded Ornament' was the fourth (equal) most-referenced piece by the press from the exhibition and was mentioned at least three times ('Penrose Strapping 1' was featured more than 'Morse'). These works were also cited as one of the least fitting folly's artistic vision (both) and the strongest ('Penrose Strapping 1') work in the exhibition by staff members of folly. 'Morse' was originally proposed to be hung from a series of tensioned wires. It was felt that this configuration could not be achieved adequately in CityLab. The alternative spiral configuration was suggested to the practitioner by the project manager.

Open Call 6. 'Sheep Jet Head' (2006) by New Zealand-based Brit Bunkley[109] is a series of interrelated artworks created with 3D modelling and animation software that applies a computer generated image of a jet plane to distort a 3D model of a sheep. Bunkley is Head of Sculpture and a lecturer in digital media at the Quay School of the Arts in Wanganui, New Zealand. In these works, the same 3D file is output in different media - for this exhibition as a physical object and as a projected animation. The physical object was fabricated by LOM™.

[109] http://www.britbunkley.com

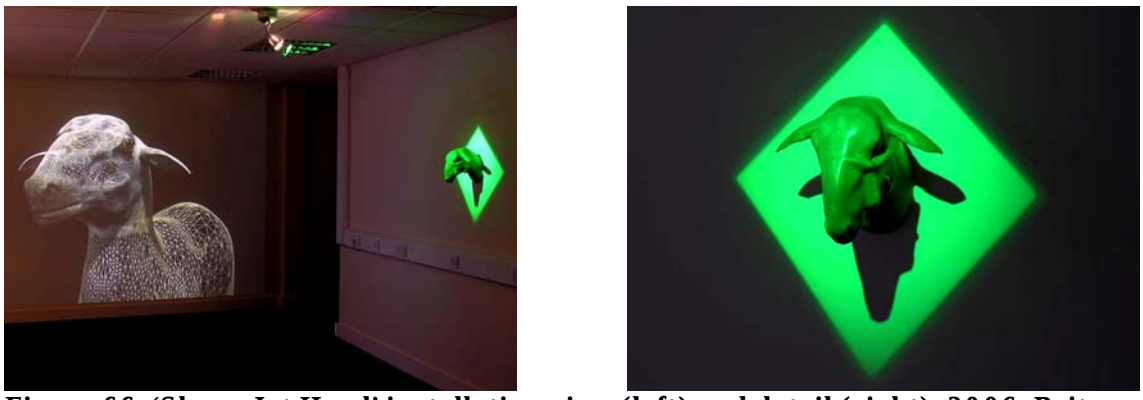

Figure 66: 'Sheep Jet Head' installation view (left) and detail (right), 2006. Brit Bunkley

'Sheep Jet Head' tied for the third most-referenced piece by the press and was mentioned at least four times. Since the exhibition the practitioner has adopted the lighting configuration that was used at CityLab as part of the work when it was shown at the New Zealand Film Archive – Wellington, 8 June - 23 June, 2007[110].

Open Call 7. 'Chicken Soup From Mars' by London-based Ben Woodeson[111] consists of fourteen pairs of handmade electromagnets mounted on cardboard boxes, plugged into the wall and placed on the floor in two locations in the exhibition. The piece reflects Woodeson's ongoing interest in technology, communication and how we treat and/or trust information. Each individual work taps out a Morse code text from or about self-help manuals. The individually titled works combine to form 'Chicken Soup From Mars'.

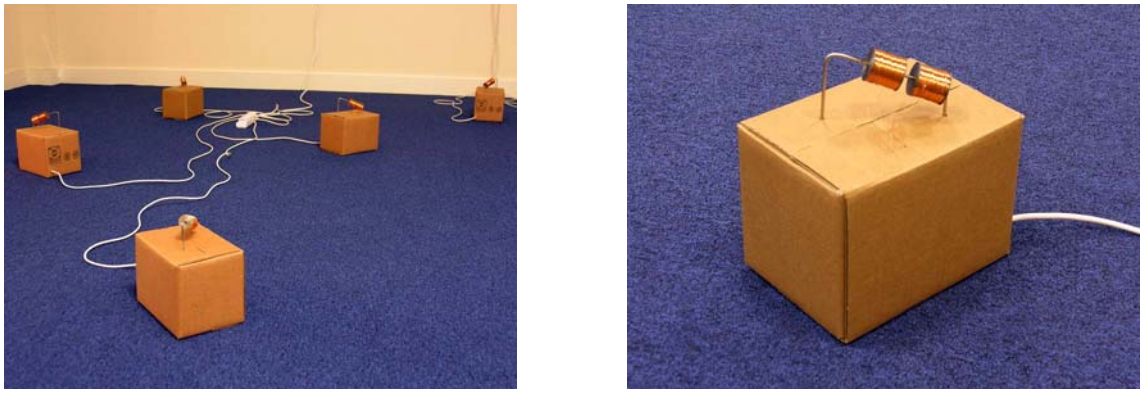

Figure 67: 'Chicken Soup From Mars', 2006. Ben Woodeson

[110] http://www.filmarchive.org.nz/
[111] http://www.woodeson.co.uk

The texts have titles such as 'A Guide To Getting', 'Confidence, Trust and Loving' and 'Grow Rich'. Different quantities of delay are programmed into each pair of magnets. This work plays with the notion of a signal-to-noise ratio[112] and the implication that our communication nearly always causes a disruption for someone else.

'Chicken Soup From Mars' was the fifth most-referenced piece by the press from the exhibition in a five-way tie with at least two references (individual works were shown in the same spaces as 'Warp' and 'Penrose Strapping 1').

Open Call 8. 'Motion in Form' by Tavs Jørgensen[113] consists of a range of objects created using Jørgensen's hand and finger motions captured via a data glove or micro scriber. Jørgensen is currently a Research Fellow in 3D Digital Production at the Autonomatic Research Cluster, University College Falmouth. Motion capture using the ShapeHand™ system[114] enabled Jørgensen to feed the motion of his hand directly into a CAD program to be used as basic 'frames' for constructing skins or solid forms (Figure 69, right).

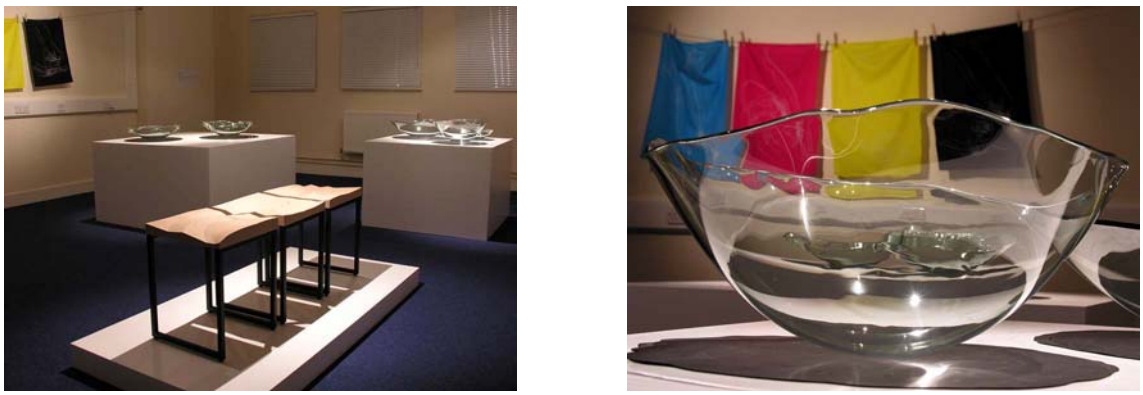

Figure 68: 'Motion in Form' installation view (left) and detail (right), 2006. Tavs Jørgensen

In the exhibition were shown five glass vessel forms based on the capture of a series of hand-drawn lines in space. In each case these lines were extruded in CAD to define surfaces that were unfolded and laser cut from thin stainless steel to form physical representations of the 3D lines. These were set it in plaster and a disk of glass heated in a kiln on top of each one resulting in a bowl form

[112] An electrical engineering concept defined as the ratio of a signal's strength to the amount of background noise that corrupts it.
[113] http://www.octavius.co.uk
[114] http://www.measurand.com/products/ShapeHand.html

defined by the glass melting over the steel. Also shown were a set of stools where the seating surfaces were CNC milled from the data captured from Jørgensen's hand motions and a set of four digitally printed tea towels with the data captured from the action of drying a mug on them.


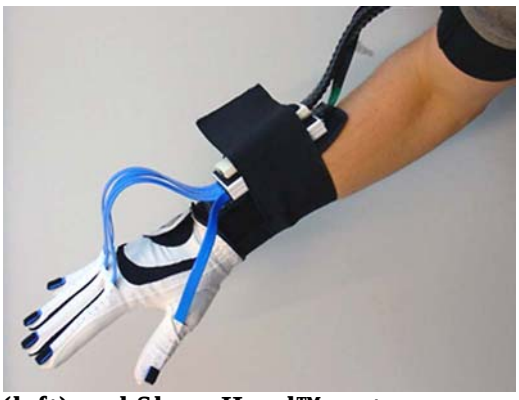

Figure 69: 'Motion in Form' installation view (left) and ShapeHand™ system (right), 2006. Tavs Jørgensen

These works were the second-most cited (25%) by the other practitioners that were interviewed as the weakest works in the exhibition. Conversely, one visitor in the audience survey indicated that 'Motion in Form' was the thing they liked most in the exhibition. These works were indicated as among the works least fitting the artistic vision of folly. Jørgensen responded to the open call by sending examples of his previous work and documentation of his process using the motion capture technology. The latter captivated the imagination of the curatorial team. The first time anyone became aware of what the objects for the exhibition were was when they were unpacked at CityLab. At the selection panel it was suggested the objects should be shown alongside documentation of the use of the data glove. This was never followed up on and would have made the contextual fit of these objects more apparent. Many visitors to the exhibition just did not make a connection to computer-based technology when viewing the glass bowl forms. Jørgensen even overstated this with laser cut rubber mats echoing the profile of each vessel – these were simply overlooked by many visitors. Also, if the curatorial team had known the exact nature of Jørgensen's objects we would have funded a small production run of the tea towels to be sold at the exhibition as multiples. 'Motion in Form' was the fifth most-referenced piece by the press in a five-way tie with at least two references. Since the exhibition this work has been featured in icon Magazine (Jackson, 2007).

Open Call 9. 'Warp' by London-based Simon Husslein[115] is a rotating timepiece originally designed for the six-storey rotunda of the Great Eastern Hotel, London. Husslein has worked on product design, interfaces, fonts, timepieces and furniture and has managed projects for clients like BMW, Panasonic and Sony. The protruding warped forms (built by the SLS® process) cast shadows of numbers from the twenty four hour clock to tell the time when each form is aligned with the light. The entire mechanism rotates once every twenty four hours.

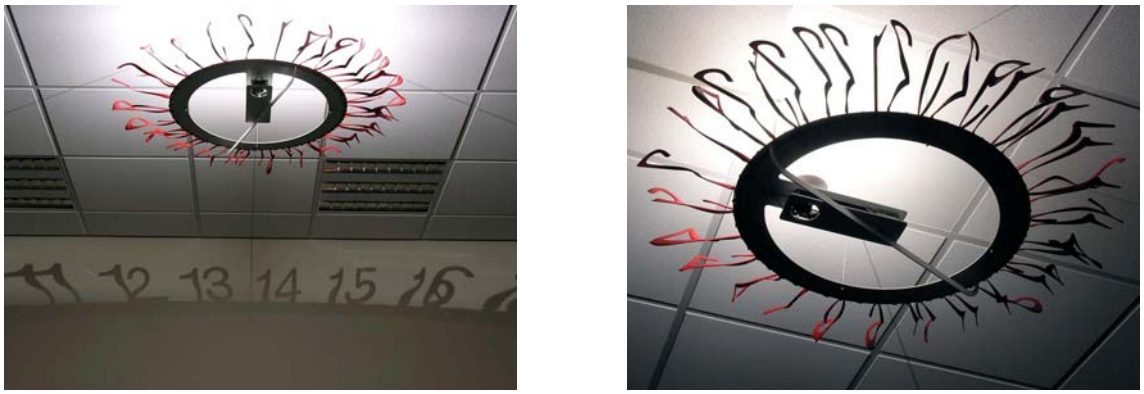

Figure 70: 'Warp' installation view (left) and detail (right), 2006. Simon Husslein

'Warp' was referenced by the press in at least one article. From the audience surveys received, one visitor indicated that 'Warp' was their most liked thing about the exhibition.

Open Call 10. 'Remember to Forget?' by Belfast-based Aoife Ludlow[116] consists of a jewellery box and related pieces of jewellery which explore notions of memory, change and habit. Ludlow works as a Research Assistant at Interface: Research in Art, Technologies and Design in Belfast, Northern Ireland. This work adds another communicative/reflective layer to the experience of wearing jewellery and the traditional interaction between person, object and container.

[115] http://www.husslein.net
[116] http://www.aoifestuff.com

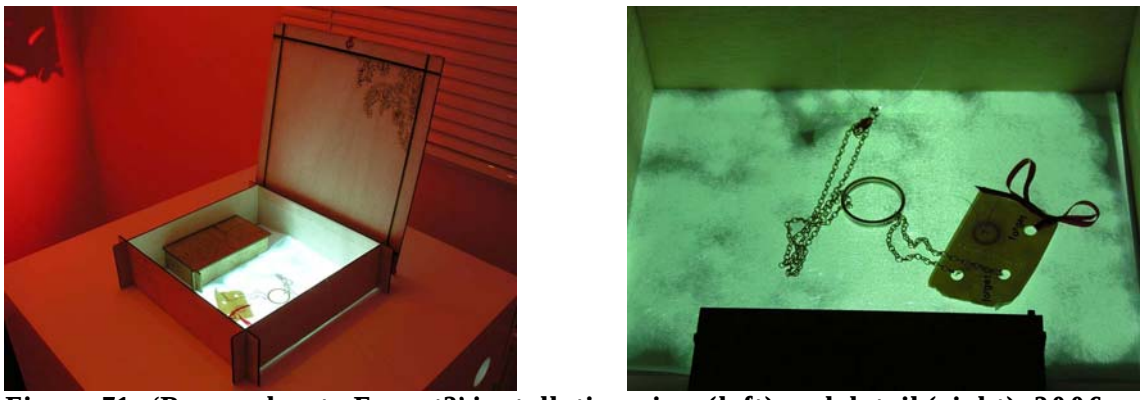

Figure 71: 'Remember to Forget?' installation view (left) and detail (right), 2006. Aoife Ludlow

Ludlow claims that interactions with jewellery objects while they are being worn are often subconscious or habit-related. Often the most conscious interaction occurs at the point of putting on or taking off the jewellery, rather than whilst it is being worn. 'Remember to Forget?' proposes designs for jewellery pieces, which contain RFID (radio frequency identity) tags and other hidden technology that tracks and records when and how long the piece is worn for, based on the time it is absent from its place in the box. The more the piece is worn the brighter the projected glow from the box, the less the piece is worn the darker the box becomes, gradually fading into the background.

'Remember to Forget?' was the fifth most-referenced piece by the press in a five-way tie with at least two references. This piece was originally sited in CityLab in the same room as 'Warp'. This set up was not working and the piece was moved at the very last minute. It was replaced with several Woodeson's 'Chicken Soup From Mars' pieces which worked much better with the ceiling-mounted 'Warp'. Also the construction of the piece was exposed in the view from the corridor. This work was moved across the hallway into the room with 'Watermark'. The red-filtered lighting in this room compromised the effect of the projection from 'Remember to Forget?' but this was considered more favourable than exposing the technical aspects of the project as had been the case in the previous location.

4.5.3 Symposium

A few the participants[117] in the exhibition had been invited to present at the symposium at the time they were contracted to contribute to the exhibition.

[117] Tavs Jorgensen Aoife Ludlow, Justin Marshall, Lionel T. Dean and Human Beans.

These were decided based on the contribution they would potentially make to the discussion, previous experience of presentations they had given and their availability on the day of the symposium. The researcher invited Bruce Sterling[118] to speak at the symposium. However, although he was enthusiastic he was already booked for a speech in the US. The researcher then invited Dr. Paul Rodgers (Reader in the School of Design and Media Arts at Napier University) to speak at symposium and he accepted and was confirmed as the keynote/moderator for the symposium. The rest of the details of the symposium were finally confirmed also, as below.

> 'Perimeters, Boundaries and Borders' Symposium
> An opportunity to hear a selection of practitioners participating in the 'Perimeters, Boundaries and Borders' exhibition talk about their work and discuss how digital technologies have enabled a convergence of disciplines, creative practice and production techniques.
>
> Venue: St. Martin's College, Lancaster Campus, Bowerham Road, Lancaster
> Date: Thursday 28 September, 1 - 5pm
>
> 13.00 – 13.30 Arrival
> 13.30 – 13.45 Welcome, Introductions (John Hyatt of MIRIAD)
> 13.45 – 14.15 Keynote (Dr. Paul A. Rodgers of Napier University)
> 14.15 – 14.35 Tavs Jorgensen
> 14.35 – 14.55 Aoife Ludlow
> 14.55 – 15.10 Break
> 15.10 – 15.35 Justin Marshall
> 15.35 – 15.55 Lionel T. Dean
> 15.55 – 16.15 Human Beans
> 16.15 – 16.45 Q+A, Discussion
> 16.45 – 17.00 Summary (John Marshall and Taylor Nuttall)
> 18.00 – 20.00 Private View at CityLab

A full transcript of the symposium is included in Appendix I. Thirty people attended the symposium. Thirteen people completed the survey (43%). The results of this survey were as follows.

[118] Based on his keynote speech at Siggraph (Sterling, 2004b).

How did you first become aware of Fast-uk or folly?	References
Online discussion list	4
Word of mouth	3
From folly	2
No answer	1

Work Sector	References
Artist	7
Academic/researcher	6
Designer/architect	5
Student	4
Arts administrator	2
Other (PhD in industrial design, research assistant)	1

	1. Strongly Agree	2. Agree	3. Neither Agree or Disagree	4. Disagree	5. Strongly Disagree
Today's symposium addressed the issues stated in the promotional materials	10	3	0	0	0
Today's symposium provided valuable insight into the topic	7	6	0	0	0

	1. Excellent	2. Good	3. Fair	4. Poor	5. Very Poor
How would you rate the quality of invited keynote speakers/lecturers?	2	10	1	0	0
How would you rate the organisation and management?	6	6	1	0	0
How would you rate the venue?	1	9	3	0	0

Question	Yes	No
Was the forum was a good mix of presentation and participation (dialogue)?	12	1
Did this event meet your expectations?	13	0

What expectations did you have at the beginning and to what degree were they met? How did they change? What was overlooked or left out?
Very personal - could be based more on general research
I wanted to get a better understanding of the relationship between art and technology - how specifically artists use technology and the insights that are gained through artist exploration. The symposium helped me understand and provoked interesting questions
Expected a diverse collection of talks, people, discourse - all met fantastically well
A short q&a after each speaker would have been good if time allowed
To find out about practices… learnt a good deal about various trends etc. in practitioners work
More in-conversation than anticipated
An interesting discourse through varied practitioners

How did you first hear about this event?	References
Email	5
Word of mouth	5
Online discussion list	1
Other	1

Why did you decide to attend this event?	References
To develop an understanding of the area as a whole	6
To network	4
To pick up new ideas	3
To fill in the gaps	1

Question	Yes	No
Are you interested in attending further similar symposiums?	10	0

Do you have any suggestions for future events or any further comments?
No, more of the same really
Some speakers could introduce themselves a bit quicker
Signpost the event

4.5.4 Practitioner interviews

This section describes the results of the interview study of six practitioners from across the 3D art and design making disciplines whose work was included in the 'PBB' exhibition.

The Exhibition (expectations)

The researcher asked each of these practitioners to reflect on their thoughts before the exhibition.

1. Where did you see the call for PBB?	
Practitioner 1	...from an **internet** search
Practitioner 2	On the **email**.
Practitioner 3	Justin [Marshall] forwarded on an **email** sent to him.
Practitioner 4	I think I just printed it off the **Rhizome** list
Practitioner 5	I was on the **internet**, some blog website.
Practitioner 6	I think our research cluster was informed by **John Marshall** of this opportunity to exhibit.

This question was asked to try to find out where the practitioners found out about the call for participation. The call was available through various electronic distribution lists and newsletters. The researcher had also sent the call to all of his personal contacts and the respondents of the survey he had conducted. The call was also posted to various blogs online. Of those that responded 3 (50%) practitioners each cited an Internet source or an email.

2. Why did you apply for PBB?	
Practitioner 1	the **description** of the exhibition is exactly what I'm doing
Practitioner 2	The exhibition **fit** exactly what I was doing at that time.
Practitioner 3	It seemed to **fit** generally into the field that I work in... I also liked the graphics on the call[119]
Practitioner 4	I came to it when I was doing some other stuff and I was putting in some submissions for some things at home
Practitioner 5	...the way it was described, the brief and **description** of the exhibition, really summed up what I was doing.
Practitioner 6	The **opportunity** to exhibit in a venue I had no previous experience of and with a broad range of makers and artists working in related but sometimes distinctly different fields.

The researcher asked why the practitioners had applied for the exhibition to try to establish what aspect of the exhibition brief was attractive to the practitioners. 4 (66%) stated the description in some way connected to what

[119] It is interesting to note that one of the practitioners specifically cited the imagery used in the call. This image was generated specifically for this purpose by the researcher.

they were working on at the time the other 2 (33%) indicated they were attracted by the opportunity to exhibit.

3. What about the brief made you think your work was appropriate?	
Practitioner 1	All I can remember is that I was absolutely; "God I should be doing this".
Practitioner 2	The combination of **technology, art and design**...that's exactly what I was doing
Practitioner 3	The visual aspects of it obviously cornered the research that's going on, it seemed generally quite broad.
Practitioner 4	...the title. I think it just summed it up quite nicely that it was all about the **edges** and it didn't matter which side you were on
Practitioner 5	I think it was the convergence between **art and technology** because that statement is very simple, but sums it all up.
Practitioner 6	My work often falls between **art, design and architectural decoration** and therefore I believed my work fitted the **cross boundary** nature of the show.

Following on from the previous question it was hoped that this question would elicit responses that would point to keywords the practitioners responded to. 4 (66%) of the practitioners specifically indicated the multi-domain aspect of the exhibition.

4. What did you expect to get out of the exhibition?	
Practitioner 1	…**opportunity** to make whatever it was I was going to make and then PR associated with that
Practitioner 2	To be **able to exhibit** this first piece of work was interesting for me to go through the process. I've done a lot of stuff before, but it never was just my name, or my vision which I had to represent.
Practitioner 3	I like to apply for exhibitions that my work fits into it gives my work some focus and a **deadline** to get work completed to.
Practitioner 4	I didn't really know I didn't really have too many expectations. I was really interested **to see what else** was going to be there
Practitioner 5	…having a **platform for showing my work**
Practitioner 6	I never know what to expect, I was hoping for some **connections** to be made with other practitioners working with architectural based work.

From these responses 3 (50%) of the practitioners saw the exhibition primarily as a means to show their work, 2 (33%) saw it as an opportunity to network with other practitioners and 1 (17%) saw it as a means of imposing a deadline on their activity.

5. Who did you expect to be in the exhibition?	
Practitioner 1	…it was a chance to **find out** who was doing what
Practitioner 2	I just expected certain people to participate with **similar interests**.
Practitioner 3	Geoffrey Mann… The exhibition was much broader than I thought but **the usual suspects** - some were there and some were missing.
Practitioner 4	I probably thought it would be a kind of more **Interaction Design** maybe or more like people from **Critical Design** stuff or maybe that kind of direction… Geoffrey Mann
Practitioner 5	Tavs [Jorgensen] would be in it, he's in bloody everything, and Justin [Marshall], it's the **same crowd** in a lot of these events.
Practitioner 6	I did not have any expectations

2 (33%) practitioners had no real expectations and 1 (17%) thought the exhibition was an opportunity to find out who was working in this area. 2 (33%) participants identified they expected Geoffrey Mann to be in the exhibition. 1 (17%) practitioner had expected 2 of the other participants that actually featured. This is an illustration of just how narrow some of these communities of practice can be.

6. Was there someone you expected to be in the exhibition that wasn't?	
Practitioner 1	Patrick Jouin, Freedom of Creation[120]
Practitioner 2	I didn't expect any one in particular.
Practitioner 3	Gordon Burnett[121] might have been expected to have some pieces in and Ann Marie Shillito[122] perhaps. It was good to see a bigger breadth than is normally seen at these exhibitions.
Practitioner 4	Jayne Wallace, Sarah Kettley[123], rAndom International, CuteCircuit
Practitioner 5	Kenji Toki, Gordon Burnett, Gilbert Riedelbauch – they're craft people, they're 'makers' and they don't want to be associated with the art world and vice-versa.
Practitioner 6	No answer.

7. Was there anyone in the exhibition you were surprised by?	
Practitioner 1	Human Beans
Practitioner 2	Human Beans… The range was **wider** than I thought.
Practitioner 3	I was surprised by how **broad** the exhibition was from very conceptual art to media based pieces.
Practitioner 4	I was quite surprised by 'What's Cooking Grandma?' but in a really good way.
Practitioner 5	I think there were some obvious ones and some surprises I didn't expect to be there, but it was very welcome, I found it very **fresh**.
Practitioner 6	The exhibition was **diverse** enough not to be surprised by anything

[120] These practitioners were on the original list of possible commissions. However, they were considered to be 'over-exposed' in that they are very widely written about and shown. It was felt that it would serve the field of enquiry more to show the works of other practitioners.
[121] Invited to apply several times by the researcher. No response received.
[122] This practitioner contacted the researcher via email but did not actually make a proposal and was therefore ineligible for selection.
[123] This practitioner applied and was scored seventh equal at the open call panel. However, the panel decided there should only be one 'interactive jewellery' piece in the exhibition and Aoife Ludlow's was more popular (4th equal). The researcher later discussed this with Kettley and Ludlow.

In general, the range of practitioners in the exhibition was not expected by these practitioners. The remit of the exhibition was more expansive than they had estimated. 5 (83%) stated they were surprised in some way. 3 (50%) were surprised by the inclusion of 'What's Cooking Grandma?' by Human Beans. The researcher hoped that this question would indicate if the curatorial process had included something that did not belong. This could also show where the limits of disciplinary discourses might be, based on the works in the exhibition.

The Exhibition (actual experience)

The researcher enquired about how the actual exhibition met or did not meet these expectations.

8. Did the exhibition live up to your expectations?	
Practitioner 1	Yes. I was expecting more of a gallery
Practitioner 2	Yes, I think so.
Practitioner 3	I was delighted with how professional it had all been organised and put up.
Practitioner 4	Because I really didn't have too many, yes.
Practitioner 5	…yes, it lived up to the expectations and surprised me at the same time
Practitioner 6	The exhibition worked well visually, within the limitations of the space. I would have liked to make more links and contacts than I did.

5 (83%) of these practitioners stated the exhibition lived up to or exceeded their expectations. 2 (33%) participants indicated they were not entirely satisfied with the conditions of the non-traditional exhibition space.

9. Were you happy with the way your work was displayed?	
Practitioner 1	I think a lot was done with the **lighting**, so yes
Practitioner 2	The architecture as an **office** environment wasn't really giving too much possibilities, but all the pieces had to fight with that situation.
Practitioner 3	There seemed to be attention to the **lighting** in particular I thought it was very good.
Practitioner 4	…it could have been better probably, but that was the **space** and… the other work that was there and the **lighting** seemed to be a bit of a problem, but that seems to be a problem with the space rather than anything that was controllable
Practitioner 5	I've had worse spaces and I've had better spaces, but no, it was fine. The **lighting** [was good] Especially the windows as well. You go past them and it's almost a still life in itself
Practitioner 6	As far as the rather bleak and sterile **space** allowed, yes.

3 (50%) of those asked responded the lighting in the exhibition contributed to their satisfaction with the way their work was displayed. 1 (17%) indicated the lighting had a negative effect on their work. 1 (17%) practitioner pointed out the glazed office environment enhanced the reception of their work whereas 3 (50%) stated the fact the building was designed for technology-based start up businesses posed a problem for them.

10. What could have been done better?	
Practitioner 1	I think if we could have had gone in and looked at the **space** sooner, maybe, and thought about the projection
Practitioner 2	…the **windows** were quite tricky… they were too high, so I made all kinds of decisions in the room, but the one I was in was ok, but it could have been more precise.
Practitioner 3	I think the **venue** was not ideal the rooms were obviously office rooms.
Practitioner 4	I think the **space** maybe was a little bit tough to work in. It was a little bit if it could have been a darker space it definitely would have suited me better. The red **light** took away from the atmosphere and it became the atmosphere of that piece rather than mine.
Practitioner 5	I think it had a major struggle in that it had '**Lancaster**' next to its name
Practitioner 6	The organisation and installation were faultless and the staff at folly extremely well organised and professional. Again the only negative element was the actual **space** itself.

Following on from the previous question 5 (83%) of the practitioners indicated the nature of the exhibition space was the one aspect they were not satisfied with. 1 (17%) practitioner thought the fact the exhibition was in Lancaster and not a major metropolitan centre was its greatest drawback.

11. In your opinion, what was the strongest work in the exhibition and why?	
Practitioner 1	Penrose Strapping 1, Warp, Flight, Chicken Soup From Mars
Practitioner 2	Wifi Camera Obscura
Practitioner 3	Sheep Jet Head, **Holy Ghost**
Practitioner 4	What's Cooking Grandma?, **Holy Ghost**, Motion in Form
Practitioner 5	What's Cooking Grandma?, **Holy Ghost**
Practitioner 6	**Holy Ghost**, Cyclone.soc

These practitioners considered that 'Holy Ghost' (31%) and 'What's Cooking Grandma?' (15%) were the strongest works in the exhibition.

12. In your opinion, what was the weakest work in the exhibition and why?	
Practitioner 1	Morse
Practitioner 2	Motion in Form (stools)
Practitioner 3	What's Cooking Grandma?
Practitioner 4	Remember to Forget?, **Wifi Camera Obscura** (disappointing)
Practitioner 5	**Wi-Fi Camera Obscura** because I didn't understand it… Tav's glass bowl - I think his making is very interesting but his outcome falls short.
Practitioner 6	**Wi-Fi Camera Obscura**. I would not say this was a weak work just that it sounded very intriguing as a concept but I was disappointed by the visualisation of the signal data, to abstract and undefinable for me.

These practitioners considered that 'Wi-Fi Camera Obscura' (37.5%) and 'Motion in Form' (25%) were the weakest works in the exhibition.

13. Were you surprised by any work in the show? Why?	
Practitioner 1	Surprise is a difficult word. I'd have to say no
Practitioner 2	I don't think there was something which went a step ahead of what I had seen before or knew of. It was within a very 'today' kind of technology
Practitioner 3	Wifi Camera Obscura… I think it was the variety and the breadth of the show rather than picking a particular piece.
Practitioner 4	**Human Beans**
Practitioner 5	Sheep Jet Head - at the end of the day it was just a sheep with a really badly drawn plane on it.
Practitioner 6	The **Human Beans** project surprised me I think because it crossed unexpected boundaries into documentary/social science/public service? Which I was not expecting at a technology centred exhibition.

Again, 'What's Cooking Grandma?' was identified by 2 (33%) of these practitioners as the most surprising work in the exhibition.

14. Did you think the exhibition was coherent?	
Practitioner 1	With the exception of the Grandmas [Human Beans]
Practitioner 2	Yes.
Practitioner 3	Yes very much it seemed to illustrate the **breadth** of the use of visual media within the arts without losing focus.
Practitioner 4	I wasn't expecting it to be as coherent I thought that it would have been a bit disjointed but it was quite coherent.
Practitioner 5	Yes… it covered a lot of ground and disciplines and was a good **showcase** for the possibilities of what is happening.
Practitioner 6	Not really, but I would not say that was the point or aim of the show.

This question was asked to try to get an insight into whether the practitioners felt the works in the exhibition 'held together'. 4 (66%) of these practitioners thought the exhibition was coherent 1 (17%) thought that it was except for the above mentioned 'What's Cooking Grandma?' and 1 (17%) thought that coherence had nothing to do with the purpose of the exhibition.

15. How would you sum up the core theme of the exhibition?	
Practitioner 1	The **interface between digital technology, craft and design** and the three things coming together and the fringes of all three.
Practitioner 2	…an exhibition about **technology in art and design**
Practitioner 3	I suppose it's the **media effect on creative practice** the possibility it provides with the **physical object** and the purely **digital** expressions and inventiveness and the **variety** which I think is a key.
Practitioner 4	I suppose **diversity** within each practitioner. We can all multi-task more than we give ourselves credit for. The **borders** are only there if you allow them to be there and you can stumble over them then something good can come of it.
Practitioner 5	I think the majority of objects, what you can get from it is there are a lot of **fresh perspectives** out there… It's new objects that can't be defined, it's **an undefined discipline**.
Practitioner 6	Don't make assumptions about **art/design works which use digital technologies**, they are as **diverse** as any other forms of practice.

These practitioners were encouraged to reflect on what the core theme of the exhibition was – based on their own experience rather than the stated objectives of the curatorial brief. 4 (66%) practitioners stated links to computer-based technologies. 3 (50%) of the practitioners specifically indicated the multi-domain aspect of the exhibition with the others alluding to it more obliquely. 3 (50%) practitioners referenced diversity or variety in their responses. These practitioners were exposed to the curatorial aims of the exhibition through the call, the symposium and the guide that accompanied the exhibition and the degree to which their responses have been influenced by these is not apparent.

16. What did you most like about the total exhibition?	
Practitioner 1	The way we had little **rooms and windows** into other people's little rooms so that kind of worked for me.
Practitioner 2	It had a **nice feeling** about it.
Practitioner 3	It was interesting, it was **engaging** – something that you wanted to explore.
Practitioner 4	It was the **breadth** of work covered, definitely. To be able to walk into one basic space and see so many different things. The Art Gallery (Siggraph) is such a big thing but in that big space they didn't cover that **diversity** of work that was covered in the small space in Lancaster.
Practitioner 5	The **diversity** of it… It was very random; the objects weren't coherent to each other, but the underlying theme was.
Practitioner 6	Seeing and experiencing the **unexpected**.

The practitioners were asked what they most liked about the exhibition in its entirety. 2 (33%) responded that it was the atmosphere and physical appearance of the show. 2 (33%) cited the diversity of work presented. 2 (33%) indicated the unanticipated nature of the work was foremost in their satisfaction.

17. What did you least like about the total exhibition?	
Practitioner 1	I guess the **location: Lancaster**.
Practitioner 2	Maybe it could have been less local in terms of **location and audience**.
Practitioner 3	The **venue**.
Practitioner 4	The **space** – it worked really well for some things but it just worked less for others.
Practitioner 5	I think I was ok with it. I didn't come away from it feeling it fell short – I think it did what it set out to do. There are no negative thoughts from it.
Practitioner 6	The **office-like space**.

The inverse of the previous question was asked of the practitioners. The least popular aspect of the exhibition for these practitioners was the condition of CityLab as a non-traditional exhibition space. This was identified by 3 (50%) respondents. 2 (33%) participants thought the fact the exhibition was in Lancaster and not a major metropolitan centre was the exhibition's most negative aspect. 1 (17%) practitioner had nothing negative to say about the overall exhibition.

18. Many visitors to the exhibition would have liked to have seen more technical information – what do you think?	
Practitioner 1	…maybe it could be something you could **opt into** if you want it, but to have it in everyone's face might spoil the magic
Practitioner 2	No answer.
Practitioner 3	Stuff like what software programmes can be used – I think that could be a real **starting point** for many visitors. The tools that we use which are an important part of what the work finally becomes.
Practitioner 4	I think that in **some cases** it would have been nice because the processes are really interesting and perhaps **more interesting** than what was finally on show.
Practitioner 5	I've been to a lot of these places and it's become like a **tradeshow** and its boring now… in an art gallery, you wouldn't expect to see how the artist painted. Perhaps you should see his thought process.
Practitioner 6	If done well and intelligently (but **not too technical**) documentation of process can add to a work.

From the audience survey that was conducted (see section 3.5.2) it was clear that some visitors would have liked more information on the technologies and processes behind the works in the exhibition. The practitioners were asked what their thoughts on this were. 4 (66%) practitioners indicated that this contextual information would have been appropriate for some works. However, they also pointed out that this was a means to an end and not an end in itself.

They indicated that this information should be optional and should not be too technical for a general audience. 1 (17%) practitioner did not think this kind of information was appropriate in the context of this exhibition. This practitioner identified the maker's thought process was more important than technical information.

The Exhibition (aftermath)

The researcher asked a series of questions to try to determine what impact if any the exhibition had in professional terms for the practitioners.

19. Have you made any new professional contacts because of this exhibition?	
Practitioner 1	Paul Rodgers
Practitioner 2	Not so far.
Practitioner 3	…**folly** is an interesting outfit
Practitioner 4	New Media Scotland[124]
Practitioner 5	I had a couple of enquiries about my work prices… and that scared them off
Practitioner 6	Contact with **folly** which I was not previously aware of.

5 (83%) practitioners stated they had made new professional contacts because of their participation in the exhibition. 2 (33%) indicated folly as a new professional contact.

[124] Cezanne Charles of Fast-uk is the Executive Director of New Media Scotland and the researcher's spouse. This practitioner was an invited speaker at a New Media Scotland event.

20. Have you received any new opportunities because of this exhibition?	
Practitioner 1	Not that I know of
Practitioner 2	(Project Manager at folly) mentioned working on something in about a year's time
Practitioner 3	The exhibition made me focus on a body of work and that body of work has since had a lot of press. The work that was made for the show has been in **Icon Magazine**.
Practitioner 4	Because it was one of the one's that was in the write up that was on **Rhizome** I got a call from the guy on the **Boston Globe**. He writes the Personal Tech Column (he's big into RFID) so he did a piece on me.
Practitioner 5	**Elle Decoration** in Russia because of it.
Practitioner 6	No.

3 (50%) of the practitioners surveyed stated their work had featured in publications as a result of the exhibition. 1 (17%) indicated they had discussed future opportunities with folly. 2 (33%) stated they were not aware of receiving any new opportunities directly because of this exhibition. It is clear that distinction needs to be made here as to what constitutes a new opportunity.

21. Has there been any impact on traffic to your website because of the exhibition?	
Practitioner 1	It has **doubled**, but it's hard to substantiate why – there's the show and the updated website.
Practitioner 2	There was **more** traffic on my website
Practitioner 3	I don't monitor it that closely I'm not sure.
Practitioner 4	Massively. About **ten times** the amount of the monthly traffic. It went up from around fifty or sixty a month to around five hundred in October and something like three or four hundred in November.
Practitioner 5	Yes, it got quite a few **more** hits than usual.
Practitioner 6	Not known.

The researcher asked these practitioners if they had observed any impact to traffic on their websites because of the exhibition. 4 (66%) of the practitioners indicated they had experienced increased hits on their website during and after the exhibition. 2 (33%) practitioners did not know if there had been any impact or not.

22. Has being in the exhibition had any effect on your work?	
Practitioner 1	**Yes**, because I've moved onto a different scale, something a lot larger than I had before, different lighting that I had never done before, we've got the real-time cracked
Practitioner 2	**Yes**, definitely… this exhibition was my first as an individual
Practitioner 3	The exhibition brought together a number of communities that can be a little bit disparate even though they all work with digital as the core of our work. There is the media-rich community and the craft-centred community and they tend not to mingle much and **the exhibition achieved that crossover**.
Practitioner 4	I think it **will**.
Practitioner 5	…it allows time to reflect - to see a piece in its purity rather than bits and stages.
Practitioner 6	Not as yet.

The practitioners were asked if their experience of the exhibition had any effect on their work. 2 (33%) responded the exhibition had effected their work. 1 (17%) practitioner indicated they thought the exhibition would have an effect in the future. 1 (17%) practitioner responded by reflecting on the broader implications of the exhibition on communities of practice. 1 (17%) practitioner saw the exhibition as an opportunity to evaluate their work. 1 (17%) practitioner stated the exhibition had no effect at the time of the interview.

23. Has being in the exhibition had any effect on your thinking about creative disciplines?	
Practitioner 1	Yes, it's the use of technology, the way it is applied, the **fresh thinking**, the **innovative ideas**… anything like that makes you question what you're doing almost like "I wish I'd thought of that"
Practitioner 2	Not specifically. It probably **proved to me** certain things that I've thought.
Practitioner 3	Yes it certainly made me think much **broader** and I tend to think as a craft-based practice you think about the physical outcome and I think a little bit broader than that now. It **opened my eyes** to a more open way of viewing this technology and what it can do for creative practices.
Practitioner 4	I think it's kind of **crystallised a bit more** what I've been thinking already. In a way I don't fit in any of the boxes that are out there at the minute.
Practitioner 5	I'm just trying to get these pieces out more. Let people see them between disciplines
Practitioner 6	No answer.

The practitioners were asked if the exhibition had affected their thinking about creative disciplines. 2 (33%) said that it had exposed them to new ideas. 2 (33%) practitioners reported the exhibition had affirmed the ideas they already had before the exhibition. 1 (17%) stated that he just wanted his work to be seen by as broad an audience as possible.

24. Would you be interested in being in another show of this kind?	
Practitioner 1	Yes definitely
Practitioner 2	Yes.
Practitioner 3	Absolutely I think that those **crossovers** are so interesting and so important no reservations.
Practitioner 4	Yes, definitely if the opportunity arose.
Practitioner 5	Definitely
Practitioner 6	Yes.

25. Would you be interested in future opportunities with Fast-uk?	
Practitioner 1	Yes definitely
Practitioner 2	Yes.
Practitioner 3	Absolutely
Practitioner 4	Yes.
Practitioner 5	I think you guys are promoting something that's very dear to my heart and **no-one else is doing it**, which is crazy.
Practitioner 6	Yes.

The practitioners were asked if they would participate in another exhibition like 'PBB' and if they would be interested in working with Fast-uk in the future. All of the practitioners answered both of these questions positively.

Technology

The researcher put the technology-related questions from the previous survey of practitioners that use computer-based design and fabrication technologies (see section 4.3) to these participants. It was thought that this might help to correlate the information gathered from these practitioners within the wider context of the study.

26. When did you first make use of computer technologies in your work?	
Practitioner 1	1970s
Practitioner 2	as an industrial design intern in 1992
Practitioner 3	1996
Practitioner 4	I'd say second year at college 2000
Practitioner 5	As an undergraduate 1997
Practitioner 6	1996

27. What formal training have you have had with computer technologies?	
Practitioner 1	2D CAD which I regard as a different discipline. It's like drafting, it's not CAD as we know it today. 3D CAD I'm **self taught**.
Practitioner 2	…it's been **learning by doing**
Practitioner 3	**Job-related** industrial training.
Practitioner 4	**Self taught** as an under graduate… A bit of basic programming (C++) and being around computer technicians if something went wrong I would make them explain what was going on, rather than just letting them fix it for me
Practitioner 5	I had to start figuring out how to do these **myself**
Practitioner 6	**Self taught** on some elements, workshop trained on some and worked with technical facilitator on others.

All of these practitioners indicated they were mostly 'self-taught'. It was clear that their experience of using technologies was task-related and project-based. This is consistent with the findings of the previous survey of international practitioners (see section 4.3).

28. How would you describe how you make use of computer technologies in your practice (e.g. concept development, design-to-order, fabrication, pre-visualisation, prototyping, etc?)	
Practitioner 1	…from concept onwards now **it's all computer-based**
Practitioner 2	I probably use it **more than I should**
Practitioner 3	**All** of the mentioned aspects.
Practitioner 4	Already answered in another question.
Practitioner 5	…now my work can't be made by hand and **I need a computer** to help me with it
Practitioner 6	Tooling, actual production of piece, master models, physical visualisation.

Unsurprisingly, when asked how they make use of computer technologies in their practice all of these practitioners indicated that use of the computer is central to what they do.

29. How have computer technologies had an impact on your practice?	
Practitioner 1	It **defines the practice**, basically. I define my work now as being focussed on design for digital manufacture. I don't do anything that isn't direct digital manufacture.
Practitioner 2	To use computers in that way is, to me, very substantial for how I **define myself** as a designer.
Practitioner 3	The emergence of digital tools has had a **great impact** on my work, but it would be very hard to summarise all the many ideas or conclusions resulting from them.
Practitioner 4	They have allowed me to do things that I want to do and **did not think were possible**.
Practitioner 5	This sounds stupid, but I can walk about, if I've been working with the computer and am **still thinking in that way**, I start imagining things moving and how it'll trace, leaving a trace echo in the sky – it's slightly sad and worrying!
Practitioner 6	All technologies, digital or not, I have used have had an impact on my practice, whether consciously or unconsciously. I believe your experience of the world is **framed by the technologies** your engage with the world through.

Following on from the previous question the practitioners were asked what impact these technologies had on their practice. All of the practitioners pointed out their practice had been transformed by the use of computer-based technologies. In addition, 2 (33%) stated the nature of their practice was **defined by the use of these technologies** and 2 (33%) indicated that use of these technologies had changed how they think about or see the world.

30. What (for you) is the key benefit of using these technologies?	
Practitioner 1	I couldn't even hold in my head... **let alone produce** [them without the computer]
Practitioner 2	...**complexity** is the key benefit - you can deal with much more and still handle them as an **individual** without having a big development team behind something
Practitioner 3	Extending the creative potential of the artistic **practitioner**.
Practitioner 4	They have **allowed me** to explore some means of expression like bits of animation which I have had a bit of an interest in but to be able to link that in a more **integrated** way to what I'm doing.
Practitioner 5	It keeps me going. It's a very **fresh way of working**.
Practitioner 6	Degree of **complexity**, accuracy and detail **otherwise unachievable**. Quick manipulation of forms within the digital environment.

When asked what the key benefit of using computer-based design and fabrication technologies was 2 (33%) practitioners thought the unique opportunities offered by these technologies to create objects not possible to produce by other means was most important. 2 (33%) practitioners noted the 'complexity' these technologies afforded was significant. These responses mirror the findings of the previous survey of international practitioners (see section 4.3). In addition, 2 (33%) practitioners indicated the ability of these technologies to shift contexts towards smaller enterprises based on the skills of individual practitioners (Bunnell, 1998) as being vital.

31. What (for you) is the key limitation of using these technologies?	
Practitioner 1	…the **expense** of producing. **Access** of technologies in terms of production
Practitioner 2	It can be an **aesthetic** limitation, you limit your thinking to what the **tools** do best or fastest or easiest… or what you understand, rather than what the shape should look like.
Practitioner 3	The lack of **direct contact** with material in the development stage. Too many possibilities can lead to lack of focus.
Practitioner 4	My limitation is my **lack of knowledge** and lack of trying to gain that knowledge or familiarity.
Practitioner 5	…it's not a **cheap** process. Apart from that, there is the **learning curve**, because it's a new skill
Practitioner 6	**Expense**, time consuming, frustrating, quality of the surface output from many RP processes.

The interviewed practitioners from the exhibition also agreed with the responses from the previous survey of international practitioners (see section 4.3) that resource issues related to the use of these technologies is their key limitation. 3 (50%) practitioners cited cost and 2 (33%) practitioners indicated the process of acquiring skill or knowledge with technologies as limitations. In addition, tool-determined aesthetics were pointed to by 1 (17%) practitioner and material and haptic limitations were also mentioned twice.

32. What is most important to you the finished object or how it was made?	
Practitioner 1	The finished object because I feel that the virtual design isn't worth anything without seeing the reality, so it has no value without that.
Practitioner 2	For me the computer has more to do with the design that with other parts of what I'm doing.
Practitioner 3	No answer.
Practitioner 4	At the moment I'm probably more interested in process than finished pieces but there's nothing nicer than seeing something at the end.
Practitioner 5	That's a tricky one for me. I think it's pretty even.
Practitioner 6	No answer.

These practitioners were evenly split on the issue of what is most important to them – the finished object 1 (17%) practitioner or how it was made 1 (17%) practitioner. 1 (17%) practitioner stated that both were equally important and 2 (33%) declined to answer. This question was asked to prompt the practitioners to reflect on their use of the computer as a tool or as a medium. This is contingent on the specific application the technologies are put to and needs to be addressed on a case by case basis.

33. What do you consider constitutes 'sophistication' in the use of these technologies?	
Practitioner 1	You have to use the tools with **some consideration, some reflection and some knowledge**.
Practitioner 2	So more clean, more simple, more natural, to me, looks more sophisticated than something which obviously shows what you CAN do with the technology. Rather then using repetition just **for the sake of it**
Practitioner 3	It is not a term I use or have a particular relation to.
Practitioner 4	…real sophistication is **knowing when to stop putting technology in**. Knowing what is enough – simplicity is sometimes ok
Practitioner 5	There are people who use **technology for technology's sake** and that can be very crude… I suppose that was the point for me of what the exhibition is about – is that it's a creative way of the application of technology and that's sophistication in my eyes.
Practitioner 6	Recognising the benefits and limitations of each different process, pushing a process/technology to its limits, using a technology in a **unique** way.

The practitioners were asked to indicate what constitutes 'sophistication' in the use of these technologies. This question was asked as an attempt to unpack the criteria these practitioners are using to make distinctions between technology-derived objects. Again the responses are similar in scope to the results previously gathered from the survey of international practitioners (see section 4.3). However, the 5th most popular response from the previous survey was the most cited by these practitioners. 3 (50%) of those interviewed stated that technology use was 'sophisticated' when it was not just for the sake of using it. Awareness derived through experience was thought to make technology use 'sophisticated' by 1 (17%) practitioner. 1 (17%) practitioner also identified 'sophisticated' technology use as having innovative results. It should be noted there is distinction between 'sophistication' in the use of technologies and 'sophisticated' objects. Further work needs to be done in this area.

34. What does the term '3D computer technologies' mean to you?	
Practitioner 1	...object based rather than text or audio [based]
Practitioner 2	Where there is a real third dimension defined in the application
Practitioner 3	3D modelling programmes and related physical development processes, such as RP and CNC.
Practitioner 4	The first things you think are 3D Studio Max and Rhino and 3D modelling software.
Practitioner 5	No answer
Practitioner 6	It could mean a variety of things, 3D CAD software, 3D input devices and 3D output devices. To me it means someone is not being very specific.

This question was originally asked in the previous survey by the researcher to prompt responses that would indicate the breadth of technologies that might be indicated by this term. However, in this case these practitioners having been selected with the primary research focus of those working in material practice using computer-based design and fabrication tools in mind the responses were fairly narrow.

35. Name up to 5 practitioners that you would identify as exemplary users of 3D computer technologies.	
Practitioner 1	Freedom of Creation, Patrick Jouin, Bathsheba Grossman, Fluidforms
Practitioner 2	IDEO, Fitch, Ora Ito, Mark Newson
Practitioner 3	Thomas Heatherwick, Frank Gehry, Jane Harris, Kenji Toki, Ron Arad.
Practitioner 4	CuteCircuit, Jayne Wallace, Emily Conrad, Sarah Kettley and Hazel White, Geoffrey Mann.
Practitioner 5	Front, Kenji Toki, Conrad Shawcross, David Goodwin, Ron Arad
Practitioner 6	Tavs Jorgenson, Drummond Masterton, Gordon Burnett, Industreal group, Materialise group.

This question was asked in order to grant the ability to produce an 'influence map' of exemplary practitioners in the field of enquiry and to establish nodal points within this. It also served to bring to the attention of the researcher practitioners that were not known previously. It was reassuring that (with the exception of some practitioners from the area of textiles) the researcher was aware of all of these.

Practice

The researcher asked a series of questions of the practitioners about the relationship between their practice and other disciplines. Further questions were asked to establish if the practitioners thought a trend towards a hybrid model of art & design practice is emerging out of the use of computer-based design and fabrication technologies.

36. In terms of discipline where do you do you locate your practice?	
Practitioner 1	I see it on the **design/art** fringe. Some pieces that I do that are art, some pieces that I do that are design and some that are going to be straight on the **boundary** of the two somewhere.
Practitioner 2	I use the term '**designer**'... what's going to probably define me in the future is the **blur between art and design** where these disciplines mix.
Practitioner 3	**Hybrid practice** or digital craftsmanship but using digital tools.
Practitioner 4	It **depends** on what I'm working on at the time
Practitioner 5	Self-defined **product artist**
Practitioner 6	Differing projects I undertake sit in different **contexts**, but predominantly within **designer/maker practice**.

The focus of this research is to explore and evaluate work happening across traditional disciplines through the use of common digital tools. When asked where they locate their practice only 1 (17%) of these practitioners was definitive that he was a 'designer'. However, he then stated that he saw his work in the future being defined in the blur between art and design. 3 (50%) stated their

practice was contingent on the context in which they were working at any given time. 1 (17%) practitioner specifically indicated that his practice was 'hybrid' in nature. The researcher is using the word 'hybrid' to indicate the increasing predisposition and ability of creative practitioners to work across two or more creative domains. However, in the next question this practitioner indicated that his understanding of 'hybrid' suggests an analogue/digital hybrid rather than a disciplinary hybrid. 1 (17%) practitioner had coined a neologism (product artist) for his practice that draws on both product design and art.

37. How would you identify the community of practice or discipline that you most closely relate to?	
Practitioner 1	**Design** I guess would be the one that's closest.
Practitioner 2	I'm sure I'll be a **designer getting closer to what is defined as art**, but using my knowledge from a design background.
Practitioner 3	It's a hybrid practice but one which is based in knowledge material with material outcomes. A **hybrid practice between digital and physical**.
Practitioner 4	Sometimes I'm closely related to traditional textile practices and sometimes… more HCI type Interaction Design
Practitioner 5	It's one of those things that you always get asked; is either are you a designer are you a maker… are you a ceramicist? I do a bit of everything.
Practitioner 6	No answer.

When asked to identify the community of practice or discipline they most closely relate to these practitioners were again far from definitive. The responses to this question helped to frame the previous question.

38. How would you define the relationship between your work and its audience?	
Practitioner 1	I guess I'd hope they'd be **consumers and buyers**, but I don't see them in those terms… It's in a magazine or a gallery.
Practitioner 2	For now it's going to be both, **clients**, companies, individuals I can reach through galleries or my website
Practitioner 3	I think that we should engage with the tools of the time of the issues of the time that's why I am interested in the digital media - I hope to be relevant. I think that is the key thing that I hope to communicate in a **contemporary context**.
Practitioner 4	**Personal**: I think it comes back to the stuff that goes on the body or being interested in the body is a location as an entity it's never going to mean the same to two people because it's personal.
Practitioner 5	I think it's through **familiarity**… people can relate to it in the way the moth flies round the light bulb. Everyone has had that experience.
Practitioner 6	Again this differs from project to project, sometimes as active **client/commissioner**, sometimes as an active **collaborator**, sometimes as relatively passive **consumer**, others just as a passive **viewer**.

This question was posed by the researcher to cause the practitioners to reflect on how their work is consumed and the role of consumers within this. It is clear from the responses that 3 (50%) of the practitioners see this relationship in more commercial terms than the others. However, this question is not clearly stated and further research would need to be undertaken to make any definitive determinations about this.

39. Do you think there is a trend towards an emerging, hybrid discipline?	
Practitioner 1	**Yes**, I think there are definite **opportunities** there.
Practitioner 2	Art and design. Technologies are a very **substantial** part of this because of the **possibilities** that you gain through the use of it.
Practitioner 3	It is about finding the creative practices of today and tomorrow and the tools that we use they are **hugely important**.
Practitioner 4	There's all that terrible **academic politics** stopping it happening on a more natural level in a lot of places… There are **not a lot of opportunities** for someone who comes from a really hybrid background. At the moment it's probably putting people off because the only place for it is within **academic research**.
Practitioner 5	That's the hybrid practices - people challenging what exists already and because they're challenging it they're manifesting a **new framework**.
Practitioner 6	There are designer makers using digital technologies crossing boundaries, but without an underlying understanding of the materials and processes they are using beyond the digital realm this can result in work which **lacks quality and deep understanding** of the field.

40. If so, what role if any does technology play in this?	
Practitioner 1	No answer.
Practitioner 2	In design it'll be very similar; people doing things in non-technological way, but the main innovations are going to relate to what's possible or how people are able to use technology.
Practitioner 3	They determine a lot about what the pieces are like and that's the reason we use them.
Practitioner 4	It's a very central role and it's a central crossover point it's **allowing people to move from one area into another** because there are **common technologies** starting to emerge or similar technologies or tools which they can use in one discipline that they can **transfer** to another.
Practitioner 5	I think **technology is a catalyst** at this point, but as we discussed earlier, maybe in ten years time the technology will be something different, but it's never going to stand still. It's helping how it's emerging, but 100 years ago a kick wheel was the latest tech but now it's traditional.
Practitioner 6	Digital technologies do open up the **potential for new practices** through the creation of data which can be used for a variety of applications and to control widely differing forms of output device. The ability to transmit data quickly and accurately also opens up **new forms of working practice**. However for me the useful, interesting, successful and/or convincing applications of digital technologies do tend to come from people who have **concentrated in a particular field** of practice.

The practitioners were asked if they thought there is a trend towards an emerging, hybrid discipline and what role if any technology plays in this. Only 2 (33%) of the practitioners were definitive in their support of this proposition. However, the practitioners were more confident in supporting the notion that technologies were increasing opportunities in this prospective area. Existing academic structures were identified by 1 (17%) practitioner as an impediment to

hybrid disciplines. Also 1 (17%) practitioner indicated that work produced by practitioners that were grounded in a specialism was more convincing but did not state how this was the case.

4.5.5 Audience survey

This section describes the results of an audience survey that was conducted during the 'PBB' exhibition. The aim of this survey was to gather qualitative statements from members of the public about the exhibition.

How did you first become aware of Fast-uk or folly?	References
From folly	6
Passing-by/local	5
St. Martin's College	5
Word of mouth	5
Lancaster ICT Cluster Group	2
Poster	2
Business Link action learning session	1
We-make-money-not-art.com	1
No answer	1

From the responses gathered 6 visitors (21%) that attended the exhibition found out about the project partners from folly. 5 visitors (18%) first became aware of them while at the exhibition or had known about folly because they lived locally and had previously heard of folly. 5 visitors (18%) had been informed by a tutor at St. Martin's College. 5 visitors (18%) found out via word of mouth. 2 visitors (7%) had heard of them through Lancaster University's research, development and business centre in Information and Communication Technologies (ICT). Another 2 visitors (7%) had seen a poster advertising the festival and exhibition. 1 visitor (4%) had discovered them at a Business Link event and another (4%) found them on the Internet.

Reason for attending?	References
Recommended	14
Type of event	6
To try something new	4
Invited	2
Interested in the practitioners	2

14 visitors (50%) attended the exhibition based on a recommendation. 6 (21%) came because of the type of event it was. 4 (14%) wanted to try something new. 2 (7%) were invited to attend and a further 2 visitors (7%) were interested in the practitioners that were featured in the exhibition.

	1. Strongly Agree	2. Agree	3. Neither Agree or Disagree	4. Disagree	5. Strongly Disagree
The exhibition was easy to find	19	6	2	0	1
The exhibition was informative and interesting	13	15	0	0	0
I found the interactive elements easy and was able to engage with them	9	11	8	0	0
I found the signage and interpretive materials useful and appropriate*	7	15	5	0	0
The staff were polite, friendly and helpful	23	5	0	0	0
The staff were knowledgeable	18	10	0	0	0

*One visitor did not respond to this question.

19 visitors (68%) strongly agreed and 6 (21%) agreed the exhibition was easy to find. 2 visitors (7%) neither agreed nor disagreed with this statement. 1 visitor

(4%) strongly disagreed with this statement. 13 visitors (46%) strongly agreed and 15 (54%) agreed the exhibition was informative and interesting. 9 visitors (32%) strongly agreed and 11 (39%) agreed they were able to engage with the interactive elements of the exhibition. 8 visitors (29%) neither agreed nor disagreed with this statement. 7 visitors (25%) strongly agreed and 15 (54%) agreed the signage and interpretive materials were useful and appropriate. 5 visitors (18%) neither agreed nor disagreed with this statement. 23 visitors (82%) strongly agreed and 5 (18%) agreed the staff were polite, friendly and helpful. 18 visitors (64%) strongly agreed and 10 (36%) agreed the staff were knowledgeable.

What did you like most about the exhibition?	References
Helpful staff	5
Diversity of works	4
Atmosphere	3
Cyclone.soc	3
Flight – Take Off	2
Interactivity of works	2
What's Cooking Grandma?	2
Holy Ghost	1
Lighting	1
Motion in Form	1
Separate rooms	1
Warp	1
Watermark	1
No answer	1

Of the 28 responses received 5 visitors (18%) mentioned the commentary from the volunteer invigilators as their favourite aspect of the exhibition. The invigilators had been briefed on the works in the exhibition by folly staff and the researcher. Many visitors were interested in the technologies and processes involved in the making of the works in the exhibition and the invigilators were able to explain more about this. 4 visitors (14%) specified the diversity and variety of works in the exhibition as the feature they most liked. 3 visitors (11%)

indicated the atmosphere and 1 visitor (4%) pointed specifically to the lighting as being the aspects of the exhibition that were most satisfying. 2 visitors (7%) found the level of interactivity with the exhibits the thing they liked best and 1 visitor (4%) mentioned they liked the use of separate smaller rooms and stated this made individual works more engaging. Also, 11 visitors (39%) cited specific works as the thing they most liked about the exhibition. 'Cyclone.soc' was the most popular work for 3 visitors (11%). 'Flight – Take Off' and 'What's Cooking Grandma?' were each most liked by 2 visitors (7%). 'Holy Ghost', 'Motion in Form', 'Warp' and 'Watermark' were each indicated by 1 visitor (4%). Some visitors made general comments about what they liked about the exhibition:

"Vibrant, fresh and engaging."
"Innovative – interesting."
"The link between the existing and the future."
"The weirdness of it all."
"It made me want to learn more about digital art."

What did you like least about the exhibition?	References
Venue	5
Nothing	5
Not enough information - building	4
Not enough information - works	4
Chicken Soup From Mars	1
Works not interactive enough	1
Overbearing staff	1
What's Cooking Grandma?	1
Wifi Camera Obscura	1
Timing	1
No answer	4

From the responses received 5 visitors (18%) mentioned qualities to do with the venue as their least favourite aspect of the exhibition. Of these the temperature in the space was cited by 3 visitors (11%) indicating that it was both too hot and too cold on separate occasions. In addition, 1 visitor (4%) referred to the fact

the exhibition 'felt a bit sterile'. The other commented on the congestion on the opening night of the exhibition. 8 visitors (29%) were dissatisfied with the amount of information available. 4 visitors (14%) wanted more explanation about the works in the exhibition and 4 visitors (11%) indicated they wanted more information about where to go in the building and were intimidated by the corporate-feeling reception area. 1 visitor (4%) found the level of interactivity with the exhibits less than they would have liked. 1 visitor (4%) mentioned they liked not knowing what the works were about so they could form their own opinion and were prevented from this by unwanted commentary from the volunteer invigilators. 1 visitor (4%) answered the timing of the exhibition was their least favourite aspect. It is not entirely clear what is meant by this. However, it could be that it was difficult to coordinate around the work day since the exhibition was open from Noon to 5pm Monday – Saturday and was not open on Sundays. Also, 3 visitors (11%) cited specific works as the thing they least liked about the exhibition. The noise produced by the tapping electromagnets in 'Chicken Soup From Mars' made it the least popular work for 1 visitor (4%). 1 visitor (4%) did not see how 'What's Cooking Grandma?' was relevant to the exhibition and 'Wifi Camera Obscura' was pointed out as their least favourite by 1 visitor (4%).

Where did you hear about the exhibition?	References
Word of mouth	14
Mailing list	5
Leaflet	2
Passing-by	2
St. Martin's College	2
Business Link action learning session	1
Lancaster Institute for the Contemporary Arts	1
Poster	1

14 visitors (50%) found out about the exhibition via word of mouth. 5 visitors (18%) were notified by a mailing list. 2 visitors (7%) saw leaflets promoting the exhibition. 2 visitors (7%) were passing-by and decided to come into the exhibition. 2 visitors (7%) had been told to visit the exhibition by a tutor at St. Martin's College. 1 visitor (4%) had heard about the exhibition at a Business

Link event. 1 (4%) had found out about it at Lancaster University's Institute for the Contemporary Arts (LICA) and 1 (4%) had seen a poster.

4.5.6 Partner interviews

This section describes an interview study of two key individuals from folly the primary partnering organisation on the 'PBB' exhibition. The primary aim of these post-exhibition interviews was to solicit their reflections on the exhibition. This offered an opportunity to capture these partner's qualitative opinions.

The researcher asked each of these individuals to explain folly's mission and to state what their role in the organisation was.

1. Can you briefly explain folly's mission?	
Creative Director	Specifically we are interested in supporting and looking at ways of supporting artists working with technology. Looking at how to help audiences understand what the implications might be and also very specifically looking at ways in which we work with audiences and whether they are acting themselves as producers or co producers of content.
Programme Manager	…folly's mission is an ever evolving mission, principally we have a distributed programme across Lancashire, Cumbria and on line. We will eventually have a venue back in 2008.

2. Can you briefly state what you do at folly?	
Creative Director	My role is **Creative Director** and that means that predominantly I set the **curatorial vision** for the organisation. Artistic vision and manage the programme team and the communication team within that which I am also heavily involved in the general organisation in development for the company.
Programme Manager	I am the **Programme Manager** I started being responsible for all the **public facing** aspects of our programme… that includes all of our exhibitions and things like film nights, etc. and festivals.

The Exhibition (expectations)

The researcher asked each of the partners to reflect on their thoughts before the exhibition.

3. How did you think PBB would support folly's mission?	
Creative Director	I know that your experience is in developing interesting and new ways of using technology, within an artistic context and specifically the relationship to sculpture and that whole area. That really opens up **a new area for us** that's not our core - the reason being that it adds another level of expertise into the mix of what we are trying to grapple with.
Programme Manager	I came from an architecture, design and a visual arts background and essentially media arts practice was relatively new to me so I very much saw it as a way in which **folly's remit could be expanded** upon. I was aware that media arts practice was evolving itself particularly in terms of object-based practice and device-based practice and this seemed to be a perfect opportunity to actually enable folly to see that too… I wanted folly to embrace particularly **a design agenda** that I thought was something that has been slightly lacking in media arts practice.

When asked how they thought the exhibition would support folly's mission it was clear from the responses that both felt that it would extend the scope of what folly had been involved in previously. They saw it as an opportunity to present work that was not just media-based but that had some form of physical manifestation. CD felt the involvement of Fast-uk brought a level of proficiency to this extension of their mission. PM saw the exhibition as an opportunity to address an under-explored area of media arts practice and have the organisation adopt a 'design agenda' that had not been represented in the work they had done to date.

4. What did folly expect to get out of the exhibition?	
Creative Director	This was much more, in my view, focused around product and tangible stuff that people could more readily experience… this gave us the opportunity to flip that back again and show some stuff that people could actually **physically experience and see the tangible value** in it and give them that kind of experience as a way in really… it was fantastic to be able to draw something which is rooted somewhere in a big **urban centre** like Manchester and be able to showcase that with folly within Lancaster.
Programme Manager	It's very much seen as a **catalyst** and it was going to enable us to deliver a wider festival so it was seen as the **anchor project** (the Debenhams or Marks & Spencer of the shopping centre).

The researcher asked what the organisation expected to get out of the exhibition. CD saw it the terms of the type of experience that could be provided for their audience that was not just screen or web-based. Also it was seen as a coup for the organisation to be able to host an event in Lancaster that would normally have been presented in a metropolitan centre. PM described the exhibition as a 'catalyst' and an 'anchor' that would allow them to build the wider f.city Festival of Digital Culture around.

5. How would you describe folly's role in the curatorial process for PBB?	
Creative Director	…obviously we were involved in the curatorial decision making and the curatorial team were coordinating that process with artists coming to us but ultimately **the curatorial vision was set by Fast-uk**. I think that about **half of the show fitted with our curatorial vision** and half of it didn't but I don't think that was a weakness. I think that's the **strength** of the show.

Programme Manager	I am pleased that we were equal partners and the discussions that we had about the selection of work and how the show fitted together was **genuinely collaborative**. The discussions we had were really quite interesting for me because it took in about scoring things and why you liked a particular piece of work and how did it fit, etc… There was **a very clear goal** and I thought that was great… My colleagues in folly have a **slightly different** feeling about some things. It never felt like a committee decision it always felt like we were having very **vital discussions**.

Both partners were asked how they would describe their organisations participation in the curatorial process for the exhibition. CD acknowledged their involvement in the selection process but stated the overall vision was set by Fast-uk. CD indicated that half of the exhibition was within folly's traditional remit. However, this was pointed to as a positive result of the partnership. PM welcomed their involvement within what was described as a collaborative process. PM also indicated the value of the specific objectives laid out at the start of the project and the consultation process by which this was achieved. Also it was suggested the PM was more enthusiastic about the breadth of the exhibition than other staff members.

6. How useful was the fast/folly wiki?	
Creative Director	I think that it was very useful in the sense that in working remotely it gave people a **shared working space**… It was also useful when inviting people to see what it was, so saying we were looking at building another partnership there was something **visual** there to direct people to that was already in existence rather than have to duplicate that work.

Programme Manager	…that ability to actually formulate the show was helped by having it **visually represented on a single page** that you scrolled through it. I'm not a big fan of wikis personally but I knew that it did help in terms of **communicating over distances** to different partners and different parts of the country even though particularly in the **look and feel** the wiki was quite instrumental in helping us to formulate that far more than say, our meetings where we were looking at work.

During the project the researcher set up a collaborative website (wiki) that was used by the members of the project team. This was used to keep track of information about the selection process for the commissions and the open call. The researcher asked the partners how useful this was. Only PM had actively posted information to the wiki. However, both partners agreed that it had been useful in coordinating between the project's many partners that were remotely located. They also thought the images posted made it a useful tool to indicate the 'look and feel' of the potential exhibition both internally and to prospective project partners.

7. What kind of practitioners did you expect to be in the exhibition?	
Creative Director	I don't know if I expected any kind of practitioner. I suppose I expected a mix of kinds of practitioners and I suppose I expected, because of the nature of your work and the vision of the project, I expected to be working with artists that are more **product-led or 3D-led**.
Programme Manager	I expected **more architects** to be in it… but I trained as an architect and I did think there was some interesting practice out there that we could have shown. I wasn't keen for us to go down the blobitecture route which is quite easy in many respects… I would still have liked to see some designs for buildings not just designs for surfaces.

The partners were asked what kind of practitioners they expected to be included in the exhibition. CD anticipated artists whose works are product-led and 3D in nature. PM had hoped that more architects would have participated.

8. Was there anyone in the exhibition you were surprised by?	
Creative Director	I suppose a positive one would have been Human Beans I didn't foresee that would have manifested itself in the way it did and **it wasn't one that I necessarily bought into** but actually was probably one of the most successful projects of the show. In terms of its installation, in terms of its work with communities and in terms of the stuff that has been ongoing since it has probably had the **biggest impact** and is still now drawing in huge numbers of people.
Programme Manager	Probably Usman [Haque] and his team, looking back at it the proposal itself was quite a full proposal a very unspirited proposal as well and it was quite retentive in what it was suggesting. What we ended up getting was very flighty - not lightweight but a curious kind of frothy project which was quite at odds with the original proposal which felt like a morgue - the original proposal felt like it was looking for dead people.

The researcher questioned the partners if any of the practitioners selected for the exhibition had surprised them. CD was positively surprised by Human Beans having not supported this choice initially. It was acknowledged that from folly's point of view these practitioners had most likely had the greatest effect on their audience of anyone in the exhibition. PM cited Adam Somlai-Fischer, Bengt Sjölén and Usman Haque because the work as presented had been substantially different than anticipated from the initial proposal.

The Exhibition (actual experience)

The researcher enquired about how the actual exhibition met or did not meet these expectations.

9. Did PBB support folly's mission?	
Creative Director	I think that it absolutely did in the sense in trying work with **different artists** and trying to **introduce audiences** to what might be possible… the feedback that I have had from audiences, stake holders and partners was that people found it **incredibly valuable** in the sense that they began to understand what it might be that we could be doing.
Programme Manager	Yes it did they enabled us to **boost our profile** in the time that we don't actually have a venue… But in terms of the actual exhibition, the physical manifestation of that provided us with **a platform** to reacquaint our existing audience with the work that we do because some people have quite a lot of difficulties with the work of folly. We were actually able to take people round the exhibition and **they now understood** the work of folly through the virtue of seeing PBB which bodes well.

Asked if the exhibition supported their organisation's mission the partners indicated that it had by supporting diverse practitioners working with technology. In addition they pointed out the object-based works had helped audiences to understand what the purpose of the organisation was in ways that could not be as readily communicated in media-based work. PM acknowledged the exhibition and the wider festival had increased the visibility of the organisation at a time when they were not venue-based.

10. Did the exhibition live up to your expectations?	
Creative Director	The only thing with that is that because it wasn't a hundred percent fit with our artistic vision they could go away with **a different idea** of what it is that folly might be trying to tackle. We are not necessarily so exhibition-led in that way and also we are not necessarily so product-led. That was a slight **conflict with the artistic vision** we are trying to drive forward.

Programme Manager	We weren't trying to fight a bland office environment we were actually trying to work with it. In many respects we tried to **push it too far** down the post-apocalyptic route particularly when it came to lighting… It was done in an economical way and felt different as you moved through the show as well. At least those individual rooms had a **different quality** to them.

The researcher enquired if the exhibition had lived up to the partners expectations of it. In general it had. CD had concerns their audience would expect more exhibition and product-led activity from them in the future when that is not their objective. In this sense there was some unease the exhibition had been too favourably received. PM expressed concerns about the treatment of the exhibition space - that it had been overdone in an attempt to offset the appearance of the commercial office development.

11. Were you happy with the way the work was displayed?	
Creative Director	Yes absolutely I was very pleased with the end result of how the work was displayed… Obviously it was being shown within a non-gallery venue which has huge implications into how that visually looks and how it feels and how **accessible** it was.
Programme Manager	I liked the way that show **felt** and the way the show **sounded**. It was annoying to have the fire doors that were tied into the fire alarm system with electromagnetic catches. We had to put up **lots of signs** to encourage people to get right to the back.

The partners were asked if they were happy with the way the work was displayed. Both responded positively. CD acknowledged the limitations of the space in terms of visual appearance and accessibility to the general public. PM also pointed to this and indicated that efforts had been made to encourage visitors to explore the building. PM was satisfied with the atmosphere of the space beyond its visual appearance.

12. What could have been done better?	
Creative Director	I still think that the choice of **venue** meant that it was quite hard for people to go in… I think there really was a **barrier** with that and with the reception and with the whole notion of it being in an **office space**… I think that what we did with the space ultimately was really successful. I felt that in the middle of the show that there was **a bit of a lull**. That really open, large space in the middle could have had more impact and powerfully used I felt that that bit kind of dipped and then picked up again and I felt that that was a bit of **a wasted opportunity**.
Programme Manager	We **didn't energise** the lobby or the façade of the building and I would have very much liked to see something happen there… The only thing that I would have done differently was change the **entry** sequence. Our Council partners were reluctant for us to do anything in that space

The researcher asked what could have been done better in the exhibition. CD indicated the issues with the nature of the space again and suggested the reception space of the building was an impediment to the public access of the exhibition. The reception area functioned as usual for the technology-based start up companies located on the upper floors of the building throughout the exhibition and this could be perceived as a barrier to open, public access. CD also pointed out the installation of 'Morse' in the central break out space[125] was a 'wasted opportunity'. PM also indicated the reception area of the building as problematic. It just didn't look like the public was welcome to wander in off the street. Also the façade of the building[126] was pointed to as a missed opportunity to indicate to the public that the exhibition was inside.

[125] This is a corridor as opposed to a room and as such there were many Health and Safety and Fire regulations that limited what could be installed in this space.

[126] During the selection process PM had advocated the inclusion of the graphic work of Alex Hetherington possibly to be applied to the glazed wall in the front of the building. This proposition was rejected on the basis that Hetherington's work did not fit the brief for the exhibition. http://www.alexhetherington.com/

13. What would you do differently if you had the opportunity?	
Creative Director	...been a bit more creative with the **marketing** to get people into that space in the first place. Or you could argue that we could have selected **a different space** altogether... People spent a long time at the show and **much longer than any other shows** that we have put on. That was a great and positive thing but there was **nothing in there** other than the work to help them feel that they could spend time there or encourage people to do that.
Programme Manager	I wanted the **process** side of things to be evident in the show as a whole and that was one thing that could have been really great and really it wasn't. So if I was going to change anything I would like to think that certain works would have evolved in a way - grow as a **working practice** taking place. It would have been wonderful to have had a **machine** - a rapid prototyping machine or a CNC mill or something like that.

Following on from the previous question the partners were asked what they would do differently if they had the opportunity. CD suggested that another venue might be better and also indicated the marketing could have been a bit more imaginative in order to draw more of an audience. CD pointed out that visitors spent a long time in the exhibition – longer than any previous exhibition folly had presented and it would have been good if there was a space where they could have sat and accessed additional information. PM indicated the exhibition could have benefited from engaging more with the processes behind the work and making these manifest to the audience. PM suggested having some digital fabrication equipment working throughout the exhibition would have added value.

14. In your opinion, what was the strongest work in the exhibition and why?	
Creative Director	Human Beans… The fact that this piece has had a life beyond that particular exhibition for me makes it very strong and it had, had a real **relationship** with the community. Wifi Camera Obscura. Cyclone.soc… I felt it was something seen already or by another artist… the dynamism that it gave those spaces and the way people have **interacted** with it made me feel that it worked very well. ['Flight – Take Off'] and that was something that **we would not normally show** at all at folly. 'Chicken Soup From Mars'.
Programme Manager	I particularly liked the Morse code installation in the middle. That spiral of plaster forms that for me was the **fulcrum** of the whole thing everything was spinning off that. I know when you get down to the basics of what that piece of work was about in terms of the off/on, zero-one, switches etc. which is all about the way that technology actually works.

The partners were asked to reflect on what they thought was the strongest work in the exhibition and why. CD cited 'What's Cooking Grandma?' because of its ongoing existence on the Internet and the links this project built with the local community. CD had initially objected[127] to 'Cyclone.soc' during the selection process but mentioned it because of the way it activated the space it was shown in and encouraged interaction with the audience. 'Flight – Take Off' was pointed out because as a conventional sculptural object it was quite unlike what folly would normally show. CD also mentioned 'Wifi Camera Obscura' and 'Chicken Soup From Mars'. PM identified 'Morse' because it was perceived to thematically and functionally act as an anchor at the centre of the exhibition.

[127] Because of its formal similarity to 'Decorative Newsfeeds' by Thomson & Craighead. http://www.thomson-craighead.net/docs/decnews.html

15. In your opinion, what was the weakest work in the exhibition and why?	
Creative Director	I suppose the ones with the **least fit to our artistic vision** might be a better way of talking about it… Justin Marshall's piece, pieces and Tavs Jorgensen's, bowls and NIO Architecten… I just felt that each of those pieces were very heavily product-led. There was **not any interaction** with the work… I think [Jorgensen's] tea towels are great but… it was how the work had been created rather than the work that was interesting in that particular piece.
Programme Manager	The 'Ibuki' object was a beautiful object but **it didn't work** the way that we thought it was going to work.

The partners were asked the inverse of the previous question to indicate what they thought was the weakest work in the exhibition and why. CD reframed the question to the work that least fit folly's artistic vision and indicated 'Morse', 'Penrose Strapping1', 'Motion in Form' and 'Watermark' because they were very product-led and not interactive in any way. PM cited 'Ibuki' because it did not function as described in the original proposal.

16. Were you surprised by any work in the show? Why?	
Creative Director	Geoffrey Mann's piece ['Flight – Take Off'] I'm surprised by the very **strong reactions** people had to that… I was surprised by the strength of the reaction to that work. For us it's so much about process and taking part but clearly there's a real passion for **seeing** something really beautiful.
Programme Manager	I think possibly the 'Wi-fi Camera Obscura' was the most surprising thing from an industrial design perspective I loved its **eccentricity** and wasn't really expecting that to be the case. I was pleased that we were able to make a second one and develop the relationship with the partners in the building

The researcher asked if the partners had been surprised by any work in the exhibition. CD pointed out 'Flight – Take Off' because it was so favourably received by the audience and it the most conventional work in terms of it being a static, sculptural work for aesthetic contemplation. PM cited 'Wi-Fi Camera Obscura' because of its peculiar, home-made qualities.

17. Did you think the exhibition was coherent?	
Creative Director	I think it was, yes. I think it was quite hard in the spaces because there was the central core and three bits that came of it so it was quite hard to bring together in the sense that the doors were shut between them so that coherence was quite hard to achieve and because of the **breadth** of the work within the show. In general I think it was a coherent show. Hardly anyone went in and loved everything. Most people went in and had favourites or **liked some bits and hated other bits**. It was coherent in the sense that even the work that I don't feel that passionate about that still fit with the **curatorial vision** of the show.
Programme Manager	Yes I did taken as a whole I think it was a good **snapshot of practice** at this time. I think that maybe I expected the show to have more of the same types of pieces of work and less a selection box. I'm very pleased with the **selection box** that we got and the overall feeling that that had.

The partners were encouraged to reflect on the coherence of the exhibition. Both thought the overall exhibition was coherent. CD again pointed out the difficulties inherent in the nature of the space and stated that this could potentially have made the show disjointed together with the wide scope of the work selected. However, CD considered there was something to appeal to every taste in the exhibition and the works were united by the common curatorial vision. PM thought the exhibition was representative of the diversity of practice currently underway in this area and positively described the exhibition as a 'selection box'.

18. How would you sum up the core theme of the exhibition?	
Creative Director	I do think as general core theme it was about **new work**, for this area, that creatively **explores technology across** art… I think it was probably less within the mix of architecture and design than was the original intent and that might have been when the curatorial panel there was **no one voice** saying make sure that there's architecture pieces in there and that kind of thing. A sense of a coherence it was **technology-led-practice** that basically touching on ideas of 3D.
Programme Manager	I think that fundamentally it was a **design** show. I don't look at it as being a visual arts show or even potentially a media arts show. Design was the key - it had a strong quality of design to it and I think the technologies that we talk about enable this varied **convergence** of practice they've all come out of the design industry. Somewhere along the line they might have been fighter jets to start of with but it's **fundamentally about design**. Even for an artist to take that type of technology there are **design sensibilities** coming out of the work.

The partners were involved in the curatorial process of the exhibition but they were encouraged to reflect on what the core theme of the exhibition was – based on their own experience rather than the stated objectives of the curatorial brief. CD suggested that artistic practice was represented more than design or architecture but indicated the exhibition was an exploration of '**technology-led-practice**' in three dimensions. PM stated the sensibilities of the exhibition were fundamentally based in design.

19. What did you most like about the total exhibition?	
Creative Director	If you wanted to make sense of any of the work you had to give it some **time**. If someone came a long way there was enough there to qualify that time and that's something that we have **found really hard** to do until now. I was **proud** of that sense of the **ambition** of it and **scale** of it and of the impact that might have on people's experience of it.
Programme Manager	It did have a **spirit** to it there wasn't anything fusty in there everything felt **vital**, alive and that had as much to do with the **juxtaposition** of works because some things could have felt quite differently if they were put together in different ways. It felt **contemporary** it felt that there was actually some blood running through the work.

The researcher asked the partners what they most like about the exhibition in its entirety. CD was proud of the ambition of it and was pleased that visitors spent so much time in the exhibition. PM enjoyed the atmosphere in the exhibition and the fact that it felt lively and active.

20. What did you least like about the total exhibition?	
Creative Director	Some of the works within it I probably **wouldn't have chosen** - certainly on my own. I least liked the fact that it was **hard to access** for people.
Programme Manager	Some of the **restrictions** in terms of movement I would have liked to have opened that up slightly - you had to work with the architecture of **the building** which meant that the last three rooms had the capacity to get a bit lost… The architecture of the building was difficult to work with and it showed.

The partners were also asked what they least liked about the exhibition in its entirety. Both cited the conditions of the venue being a commercial office development and the implications of this on the accessibility of the space to the general public.

The Exhibition (aftermath)

The researcher asked this series of questions to try to determine what impact if any the exhibition had in professional terms for the partner organisation.

21. What feedback from the local community did folly receive about PBB?	
Creative Director	Great feedback and we don't often get great feedback. The biggest thing was that people were really **proud** and pleased to have something of that quality and calibre in Lancaster. Not just the sense of scale but the sense of cutting-edgeness about it, the feedback predominately was this looks like something that **should be in London**. So there was a real sense of pride in that. I think that was the biggest thing that it was successful in achieving and people spent **time** there, people took their family there more than we have had before. People found that it helped **make sense** of what on earth art and technology might entail.
Programme Manager	we were very consciously talking to all our visitors during the run and it was nice to find that people actually **understand folly better** because of this particular show... it was also great for **Lancaster** to have such a high quality exhibition which traditionally would have gone to Manchester, Glasgow or London.

The partners were asked what feedback they had received from the local community. Both responded there was a sense of pride in the fact the exhibition had taken place in Lancaster rather than a major metropolitan city. They also reiterated they felt the local community had a better understanding of what it was that folly did because of the exhibition.

22. What feedback from peer organisations did folly receive about PBB?	
Creative Director	Feedback from other partners and stakeholders has been positive, other art organisations within the city feedback has been **really positive** but peer organisations working within this field, I don't think that many people attended… I don't think that's specific to PBB… it was on pretty much the same time as the [Liverpool] Biennial and those people that did come did say "Wow this is really interesting stuff, I'm not used to seeing stuff like this, I think **this is more interesting than the Biennial**." I think we should have opened on a Sunday. We have opened on a Sunday in the past but Lancaster itself is dead on a Sunday but quite a few people that would have come from further afield said to me afterwards "I was coming but **it was shut on Sunday**."
Programme Manager	folly didn't have the best track record in terms of working in partnership with local partners and what it **enabled** us to do was encourage people to see the work that we do… That has enabled us to establish good **new working relationships** with people who now understand the quality of the work that we do and want to **develop** new projects with us.

The researcher enquired what feedback folly had received from peer organisations about the exhibition. CD indicated that local organisations had responded positively but the exhibition had struggled to draw peers from the wider region. The exhibition happening at the same time as the Liverpool Biennial was pointed to as a possible cause of this but CD acknowledged that folly normally had difficulty attracting peers from outside Lancaster anyway. It was suggested the exhibition would perhaps been visited by representatives of peer organisations had it been open on Sundays. PM stated the exhibition had allowed folly to establish new relationships with local organisations that wanted to develop future opportunities with them.

23. What feedback from funders did folly receive about PBB?	
Creative Director	Really great, mainly the great stuff came from the City Council and the County Council, which for us is fantastic… our two key allies within the Arts Council - so our Lead Officer and our Head of Visual Arts who gave some really **positive feedback** about the **scale**, the **ambition** and the presentation of it.
Programme Manager	There isn't an arts officer within the Lancaster City Council - the people we worked with had far more to do with the regeneration side of things and they were **thrilled**. We had actually managed to **energise** a building… Now the ground floor which we used **has now been let** so the Council are very happy about that.

Similarly the researcher enquired what feedback folly had received about the exhibition from funders. CD indicated the City and County Councils and the Arts Council were very pleased. CD specifically mentioned that ACE was positive about the scale and ambition of the exhibition. PM pointed out the entire ground floor of CityLab had been leased by the end of the exhibition and the City Council were delighted with this result.

24. Has folly made any new professional contacts because of this exhibition?	
Creative Director	Obviously all of the artists that we worked with – we hadn't worked with any of those artists before so that was a real **opportunity** for us. We also **grew** our volunteer database through this particular show because it offered people an obvious way into an arts organisation.
Programme Manager	Obviously we have maintained contact with the artists… So it's **enabled** us to **expand our network** and have a nice easy **open relationship** with a number of practitioners now. We have an **immediate awareness** of what's happening in **a much wider field** than normally we would have. So that's good very productive for folly.

The partners were asked if folly had made any new professional contacts because of the exhibition. Both mentioned the fact that the exhibition had broadened the network of practitioners that folly was aware of and saw this as an opportunity. CD indicated the exhibition had allowed folly to expand the number of volunteers willing to work with the organisation.

25. Has folly received any new opportunities because of this exhibition?	
Creative Director	I feel that based on this and f.city there are many more opportunities for us to pursue of that ilk and people are **more willing to work with us** because of the calibre of what we can deliver is strong. The **press** that was covered has been really positive. That has led to more people being **aware** of us.
Programme Manager	Not directly, we've had a number of requests for more information about certain projects. One of the artists whom we rejected for PBB asked us to be **part of a show in Valencia** in 2008 so they didn't take it too badly.

The researcher asked if folly had gained any new opportunities because of the exhibition. CD stated that because of the wider festival there was would be more opportunities available to the organisation in the future because more people felt they understood what folly was about and were more likely to work with them because of this.

26. Has there been any impact on traffic to folly's website because of the exhibition?	
Creative Director	…during the period of the exhibition and the festival the …traffic massively **went up** and then it dipped again since because there was less activity… The thing that has had the biggest impact is the Human Beans piece the amount of **downloads** from that piece after the exhibition has been massive.

Programme Manager	I'm not really sure, during the festival everything went **off the scale**, 'What's Cooking Grandma?' particularly in terms of downloads there. If I was honest the [visitor] figures for the figures for the exhibition were **disappointing** and we have subsequently shown with certain types of projects in certain locations we can actually get a much higher daily footfall into a project.

When asked about the impact on folly's website traffic the partners indicated there had been a substantial increase during the time of the exhibition (12,500 hits in 3 weeks) but that this had returned to normal levels since then. They both pointed out that 'What's Cooking Grandma?' continued to get a large number of hits. PM indicated there was disappointment at the number of people that visited the actual exhibition (593).

27. Has being involved in PBB had any effect on what folly will do in the future?	
Creative Director	I think it probably has because it has made us realise that like I was saying right at the beginning about the **tangible nature** and some ways in for audiences is to better understand the work of the artists that we work with and the work that we do. So I think that will probably feed into our **curatorial thinking** from now on.
Programme Manager	Absolutely! Media art practice is ever evolving; ever expanding. Through virtue of doing this particular show it just **broadened our horizons** so much more. To be able to do that here in Lancaster rather than doing it by going to see a show in Berlin or San Jose was great because the **team benefited** from doing it.

The researcher asked if being involved in the exhibition would have any effect on what folly would do in the future. CD and PM indicated the curatorial vision of the organisation would be more focused around tangible stuff that people can more readily experience in future. PM remarked the experience of working on the exhibition had positively impacted on the new team structure at folly.

28. Has being involved in PBB had any effect on your thinking about creative disciplines?	
Creative Director	I don't think it has.
Programme Manager	I've benefited from having my **eyes opened** a little bit more. We worked on inviting certain people to make proposals and if anything we found that the more interesting work was coming out of the open call. I know that you worked quite hard at getting certain people to make proposals in the open call and that has **influenced me** in terms of how we are developing f.city for 2007.

The partners were asked if the experience of the exhibition had any effect on their thinking about creative disciplines. CD did not think it had. PM thought that it had made him think more broadly. PM also thought the experience of the exhibition would alter folly's approach to commissioning in the future. They were more likely to solicit work from open calls and participate in the development of new works because of the experience of 'PBB'.

29. How did you find working with Fast-uk?	
Creative Director	…we should have been a bit more thorough with our negotiations around how we wanted to tackle the **marketing** side of it as there was a bit of tension there in the middle… The opportunity to work with so many **new artists** and the opportunity to be involved in that curatorial decision-making element. I think that if we hadn't had that part of it, it would have been more of a delivery role but because we felt very involved in that there was **ownership** from our side on that so I think that worked well… we felt quite clear where our responsibilities lay and where yours did. That could have been difficult but it didn't seem to be, that was successful.

Programme Manager	I know that we had some difficulties on being on brand with PBB and the way that we were communicating it. We did agree on terms of how we were to describe the project and that did go awry because there were different people who were understanding the project in different ways… I was really thrilled from a **curatorial perspective** that we were able to work together and delivering the workshops and all the added value to it as well.

The researcher prompted the partners to reflect on how they found working with Fast-uk. Both responded positively about their involvement in the curatorial process. Both also remarked on the issues that arose over the branding and marketing assets. This was the only negative aspect of the process. PM identified the cause of this as misunderstanding on the part of folly's marketing communications staff and acknowledged there was no reason there should not have been consistency throughout the project.

30. Would folly be interested in partnering on another show of this kind?	
Creative Director	Yes actually one of the things that it kind of feeds into is **a model** for us to consider working with… Ultimately you were paying us to deliver a service so this is where I think it has got slightly blurry with what our role in the curatorial panel was because ultimately you were a client of ours and we were a service provider of yours… it's certainly a model that we are **looking at further development**. It's hard to say because we wouldn't have been able to do it without that project management fee. It's just a fact we don't have that capacity of resources so it was essential for us to work in that way. However, the **partnering model** is a stronger model so somehow to get that mix. The optimum mix would be what we tried to achieve on a next time. So yes absolutely interested in doing work in that way again. It gives us the opportunity to work on a **bigger scale** with new artists.

Programme Manager	Of course and we did extend an **invitation** to you in terms of f.city 2007… Fast-uk is a very different organisation than folly - it has capacity issues in terms of the work that it does but it does do very interesting projects. I do envisage that we will work together on something in the future but I think it should enable both of our organisations to grow in the way that **PBB enabled folly to grow**.

The researcher asked if folly would consider partnering on an exhibition of this nature in the future. CD stated the partnering model was stronger and more attractive than the service provider model and that this was something that folly wished to develop further in future. PM pointed out that Fast-uk had already been invited to participate in another folly festival.

4.5.7 Press citations

References to the 'PBB' exhibition in print and online were collected by the researcher. Twenty-one of these were considered to be from sources of sufficient objectivity or peer review to be worthy of counting (see Table 16). These have been listed with the main interest group that the citation is targeted to.

Date	What	Where	Who	Communities
26/08/2006	Wifi Camera on wmmna	http://www.we-make-money-not-art.com/archives/008888.php	Adam Somlai-Fischer, Bengt Sjölén and Usman Haque	art, design, technology
29/08/2006	Wifi Camera on Boing Boing	http://www.boingboing.net/2006/08/29/camera_paints_wifi_s.html	Adam Somlai-Fischer, Bengt Sjölén and Usman Haque	technology, futurism, gadgets
08/09/2006	Wifi Camera on pasta and vinegar	http://liftlab.com/think/nova/2006/09/08/wifi-camera-obscura/	Adam Somlai-Fischer, Bengt Sjölén and Usman Haque	human-computer interaction
10/09/2006	Guardian/Observer piece mentions PBB	http://travel.guardian.co.uk/nwda/story/0,,1857397,00.html	FutureFactories, Brit Bunkley	general
11/09/2006	PBB on wmmna	http://www.we-make-money-not-art.com/archives/008934.php	Simon Blackmore	art, design, technology
12/09/2006	f.city/PBB on BBC Lancashire	http://www.bbc.co.uk/lancashire/content/articles/2006/09/11/fcity_feature.shtml	PBB	local

Date	What	Where	Who	Communities
28/09/2006	f.city/PBB in Lancaster Guardian	http://www.lancasterguardian.co.uk/ViewArticle.aspx?SectionID=134&ArticleID=1794380	Brit Bunkley	local
29/09/2006	PBB on Rhizome	http://rhizome.org/news/story.php?&timestamp=20060929	Aoife Ludlow, Tavs Jørgensen, Gavin Baily and Tom Corby	new media art
29/09/2006	PBB on Networked_Performance	http://transition.turbulence.org/blog/2006/09/29/perimeters-boundaries-and-borders	Aoife Ludlow, Tavs Jørgensen, Gavin Baily and Tom Corby	network-enabled practice
02/10/2006	What's Cooking Grandma on Freestyle CBC/Radio-Canada	http://www.cbc.ca/radioshows/FREESTYLE/20061002.shtml	Human Beans	general
04/10/2006	Holy Ghost on Designspotter	http://www.designspotter.com/weblog/archives/2006/10/holy_ghost.php	FutureFactories	design
06/10/2006	Holy Ghost on core77	http://www.core77.com/blog/object_culture/holy_ghost_by_future_factories_4722.asp	FutureFactories	industrial design
13/10/2006	f.city/PBB review in MANET	http://www.ma-net.org/review40_LClarke.html	Ben Woodeson, Human Beans, Brit Bunkley, Gavin Baily and Tom Corby, Simon Blackmore, FutureFactories , Simon Husslein, Masaru Tabei and Yasuno Miyauchi	new media art, regional
18/10/2006	PBB on Generator.x	http://www.generatorx.no/20061018/exhibition-perimeters-boundaries-and-borders/	Justin Marshall, Gavin Baily and Tom Corby, FutureFactories	generative art and design
21/10/2006	PBB on Eyebeam reBlog	http://www.eyebeam.org/reblog/archives/2006/10/exhibition_perimeters_boundaries.html	Justin Marshall, Gavin Baily and Tom Corby, FutureFactories	art and technology
02/11/2006	PBB on wnmna (China)	http://www.we-need-money-not-art.com/?p=1181	Justin Marshall, Gavin Baily and Tom Corby, FutureFactories	new media art

Date	What	Where	Who	Communities
01/12/2006	a-n Magazine reviews f.city/PBB	p11	Gavin Baily and Tom Corby, Ben Woodeson, Geoffrey Mann, Brit Bunkley, FutureFactories	art
26/02/2007	f.city/PBB profiled in ACE newsletter	p13-14	Geoffrey Mann	art
01/03/2007	Bruce Sterling posts on PBB in his Wired blog	http://blog.wired.com/sterling/2007/03/in_a_word_whoa_.html	Photos of PBB	technology
01/04/2007	Wifi Camera Obscura featured by Visualization Society of Japan	Journal of Visualization Vol. 10 No. 2 (2007) 135	Adam Somlai-Fischer, Bengt Sjölén and Usman Haque	computer-aided visualisation
19/04/2007	Radio 4's Woman's Hour features What's Cooking Grandma?	http://www.bbc.co.uk/radio4/womanshour/04/2007_16_thu.shtml	Human Beans	general

Table 16: List of press citations

4.5.8 Summary of public exhibition and symposium results

The researcher developed a curatorial framework for a themed public exhibition exploring art and design practice using computer-based design and fabrication tools. A number of the participants from the exhibition were also invited to present at a symposium. These events offered opportunities to capture data from practitioners that use computer-based design and fabrication tools from across the 3D disciplines of art and design. They also allowed the researcher to survey existing works, explore future trends, gather audience and peer responses and engage the broader community of interest around the field of enquiry. The critical, contextual review suggested the introduction of new technologies can disrupt and therefore change the way practitioners perform tasks. The exhibition and symposium granted the researcher primary access to diverse practitioners with established digital practices. This afforded the opportunity to make comparisons and gather insights into key aspects of their relationships with the tools they use and the objects they create. This contributed to a general theoretical understanding of the adoption of these technologies by practitioners and allowed for the construction of an indicative snapshot of the field of enquiry at the present time.

4.6 Development of analytical models

These models were developed out of and incorporated back into the critical review of designed objects. They were also used to frame the work conducted throughout the study in a broader context.

4.6.1 Technology adoption models

The researcher applied the phasing developed from the Apple Classrooms of Tomorrow (ACOT) project (see section 3.6.1) as an indication of the level to which computer-based design and fabrication technologies have been integrated within a given practitioner's practice. This model is an evolutionary model divided into five phases, i.e. Entry, Adoption, Adaptation, Appropriation and Invention. This model has been used as a method of analysis in the critical review of one hundred and forty-eight designed objects produced by a wide array of practitioners (see section 4.2.1). These were applied as three indicative stages: 'Entry-Adoption', 'Adaptation' and 'Appropriation-Invention'. In

adapting the technology adoption model it was hoped that it would give a clear frame of reference for how the technologies are being integrated into practice by practitioners. In the application of these three stages to the database of designed objects the researcher's ambition was to make explicit whether a relationship could be discerned between the designed objects and their development through computer-based design and fabrication technologies.

4.6.2 Klein group model

One of the researcher's stated objectives for this research study was to develop a contemporary version of Rosalind Krauss's 'Klein group' model from the essay 'Sculpture in the Expanded Field' (Krauss, 1979) that takes into consideration developments in the field from the use of digital technologies. The researcher acknowledges there are many such possible versions of this model. However, the version developed in this study reflects the researcher's practice and interests out of which the original research questions emerged.

The researcher began the updated Klein group with the category of 'digital sculpture' as that which is 'not architecture' and 'not product design'. (Obviously within this study this concerns examples that seek to re-examine object making using computer-based design and fabrication tools from a synthetic or pluralist perspective). This was expanded to include the implicit relationships of these negative terms to their positives ('architecture' and 'product design') as a set of binary pairs. As well as these five categories the researcher indicated three new positions that this conjunction granted the 'permission' to think of: the conjunction of 'product design' and 'architecture', the conjunction of 'product design' and 'not product design' and the conjunction of 'architecture' and 'not architecture'.

The researcher contacted Rosalind Krauss (now a professor at Columbia University) by email and sent an intermediate version of the updated model. It was pointed out the research aimed to map an area of practice that exists in the space between existing, conventional notions of creative disciplines. And that it proposed the work done with computer-based design and fabrication technologies forms a hybrid cultural discourse that could operate as a means of coordination and alignment across disciplines and a means of translation

between them. Professor Krauss responded the researcher had engaged flawed logic in using this method:

> "The key to the expanded field is to locate the binary that defines the object you want to expand... You need to clarify for the logic of the Klein group to make sense. You might refer to Jameson's Political Unconscious[128] where it is important and explained in his Introduction." (From an email received 16/12/2006)

The Klein group is founded on a binary opposition. However, it is precisely this sort of dichotomous thinking that this study seeks to eclipse. In proposing a hybrid art and design practice the researcher is making an argument for a post-disciplinary or pluralist approach to object making. Krauss's issue was that 'product design' is not a part of a binary that is at the heart of architecture. She is right. However, the researcher reframed the study by taking the approach the study does not concern the whole of 'Architecture' just 'building design'. The Arts and Humanities Research Council (AHRC) defines art and design thus:

> "Art and design may include: painting; public art; sculpture; performance; installation; time-based art; printmaking; photography; screen productions; virtual reality; multimedia; digital and interactive art and design... The Council will also support research in architecture that concerns *building design* (but not structural or civil or other aspects of engineering)." (Arts and Humanities Research Council, 2003)

By viewing the activity of design as an integrative process common across traditional domains this flaw in the original negative proposition was avoided. The researcher was able to logically extend the definition of digital sculpture, creating an expanded field for 3D computer-based art and design practice. The next step was to map the three new positions and establish if there were existing examples to relate the critical discourse across subject domains to relate these to. From the critical, contextual review undertaken there seemed to be several categories of practice that would satisfy these conditions (Figure 72).

[128] Jameson, F. 1981. The Political Unconscious: Narrative as a Socially Symbolic Act. Ithaca, New York: Cornell University Press.

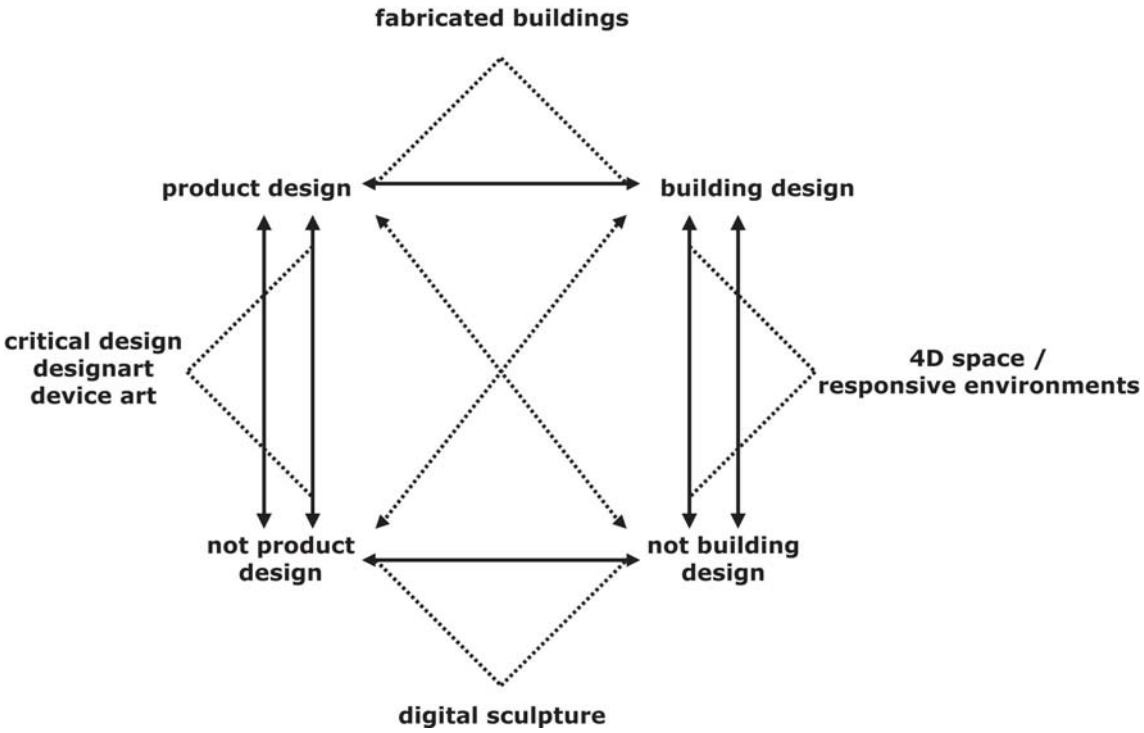

Figure 72: A contemporary version of R. Krauss's 'Klein Group' used to model the context within which the researcher's practice is located.

The conjunction of 'product design' and 'building design' suggests the activity undertaken by architecture firm Sharples Holden Pasquarelli's (SHoP) on their Camera Obscura for Greenport, Long Island, New York. The architects claim this to be the first building to be entirely computer designed and CNC fabricated. The building consists of a kit of digitally designed, custom-made parts in a way more usually related to consumer product development. Other examples of this would be NIO Architecten's 'Amazing Whale Jaw' bus station at Spaarne Hospital in Hoofddorp, The Netherlands. This structure was CNC machined from polystyrene. The various parts were assembled on-site, glued together and coated with polyester resin. Another so far unbuilt example would be Thomas Heatherwick Studio's proposed temple for Kagoshima, Japan. The design of this structure was captured from a laser-scanned piece of fabric. These all represent examples of the development of a new order of object: 'fabricated buildings'. These explore the potential of computer-based design and fabrication tools that might afford the implementation of new production paradigms, design vocabularies and methodologies. The use of computer numerically controlled (CNC) fabrication has created the ability to generate construction information directly from design information which has fundamentally changed the relationship between conception and production.

The conjunction of 'product design' and 'not product design' could be interpreted in several ways. 'Critical design' (as defined by Anthony Dunne and Fiona Raby) and its variations (see section 2.9.7) is an alternative approach that results in objects which afford critical reflection on and expose assumptions of design practices. Critical design makes use of designed objects as a form of material commentary on consumer culture. This can involve the process of design, the object and the reception by an audience of such an object. By this means critical designers will often challenge expectations and preconceptions causing new ways of thinking about objects, how we use them, and how they might effect the environment. Critical designs may be fully realised and functioning or might act as a form of speculative design. However, Dunne and Raby's most known work (Placebo, 2000-2001) is conventional in terms of how the objects were produced[129]. They utilise CAD as a means of sending design specifications to a traditional materials-based maker. The objects themselves were produced within a conventional production paradigm and design vocabulary:

> "The design process behind the objects was pretty traditional. Computers were used to make very simple drawings (plan, elevation, sections etc), and to source components and communicate, etc. They were all made by hand by a very skilled craftsman we often work with, he doesn't even have email!" (From an email regarding the creation of the Placebo project received 18/04/2005)

Another example of critical design that makes more use of the computer as a tool for design and making would be Guinea Pig Design's (Powell, 2005) '...inside the box' project of prototype 'conceptual electronica'. These are augmented objects that are designed to engage with parallel standards to the dominant values of established design discourse. This series of objects consists of a range of CNC laser-cut acrylic domestic items with embedded electronics whose sole function is to challenge conventional use. The use of computer-based design and fabrication tools to challenge expectations and preconceptions offers other possibilities for alternate cultural contexts for objects. For example, after Ito Morabito was kicked out of design school after only a year (Thompson, 2004, p.78-82), he decided to use renderings of 'unreleased products' as cultural interventions. His then-fictional company, Ora Ito designed fake

[129] "Made MDF and usually one other specialist material, the objects are purposely diagrammatic and vaguely familiar." (Dunne and Raby, 2001, p.75)

products with the branding of well-known companies on them and he published them on his website. The hijacked brands became aware of this when they were inundated with orders for these virtual products. Fiction became reality when Ora Ito was subsequently hired for genuine, high profile design jobs. These are new models of practice that yield a greater integration between art and design disciplines either by approach or output.

Although Alex Coles has since backed away from the term 'DesignArt' (because the term has been 'hijacked by glossy lifestyle magazines') the continuum of activity[130] indicated by this term can be understood as an expanded cultural field representing a conjunction of 'product design' and 'not product design'. 'Designart' could indicate 'contingent', 'dialogistic' or genuinely 'hybrid' models of practice (see section 2.9.7) that generates a new sense of disciplinary boundary shifting that draws on the critical discourse of intersecting disciplinary domains. An example of this would be Erwin Driessens and Maria Verstappen's 'Breed' that was developed as a response to the continual demand for novelty art by art institutions and journals. This is a computer programme that uses an algorithm to generate forms (digital sculpture). This software responds to previous states in the growth of an object through a process of mutation and selection based on splitting a single cube into eight new cubic units that exist in a binary state (either empty or full). In their turn, these full units are split into eight new units and so on. These practitioners consider this work is about the creation of the algorithm rather than the resulting generative objects (which are produced in Nylon by the SLS® process). Oliver Vogt and Hermann Weizenegger's 'Sinterchair®' also made by the SLS® process and computer-generated from input from the consumer could also be located in this category. Lionel T. Dean's 'Tuber9' pendant LED lamp (the prototype of which is in the collection of the Museum of Modern Art (MoMA) in New York) can likewise fit here.

Another example of the conjunction of 'product design' and 'not product design' is the 'Device Art' project. This is a concept for re-examining the relationships between art, science and technology developed by Machiko Kusahara. Device

[130] In terms of 'DesignArt' being used as a reciprocal term to produce a new speculative type of work somewhere in-between art and design.

art is a form of media art that integrates art and technology as well as design, entertainment, and popular culture targeted at audiences beyond galleries or museums through mass production and commercial distribution. This includes contemplative, functional and interactive objects that are hybrids of products, toys, and sculpture. This would include autonomous objects such as Maywa Denki's 'Sei-Gyo' ('Holy Fish') a fish-controlled vehicle that moves in the same direction that it's 'driver' swims and Ken Rinaldo's 'Autotelematic Spider Bots' that interact with their human observers, each other and their environment. Another example would be Roxy Paine's art-making machine 'SCUMAK' that fabricates 'sculptures' at the rate of one per day from molten low-density polyethylene. These projects express alternate standards to the dominant values of established art and design discourses. Guinea Pig Design's '...inside the box' objects would also fit comfortably within this category.

The conjunction of 'building design' and 'not building design' suggests the development of new forms of technological engagement of space in new ways beyond designing and making buildings. Lucy Bullivant has described this as '4dspace' (Bullivant, 2005) - emerging practices in interactive architecture that make use of various technologies such as sensing mechanisms as a 4th time-based dimension. She has also written about 'Responsive Environments' (Bullivant, 2006) that interact with the people who use them. Examples of these would be Elizabeth Diller and Ricardo Scofidio's 'Blur Building' (Diller and Scofidio, 2002) that was regulated by an array of sensors which responded to the conditions of temperature, humidity, wind speed and direction to adjust the nozzles and maintain a cloud of water vapour around the structure. Also 'D-tower' by Lars Spuybroek and artist Q. S. Serafijn that maps and displays the emotions of the local community by changing colour in response to surveys conducted of fifty local residents on the internet. And 'Blusher' by architectural collective sixteen*(makers) is a gallery-based installation that incorporates embedded sensing and actuation technologies that changes its configuration based on the proximity of the audience. Another example would be 'HypoSurface' that was developed by the architectural/design practice dECOi. This project operates through a matrix of actuators and responds to the sound and movement of it's with its audience or users.

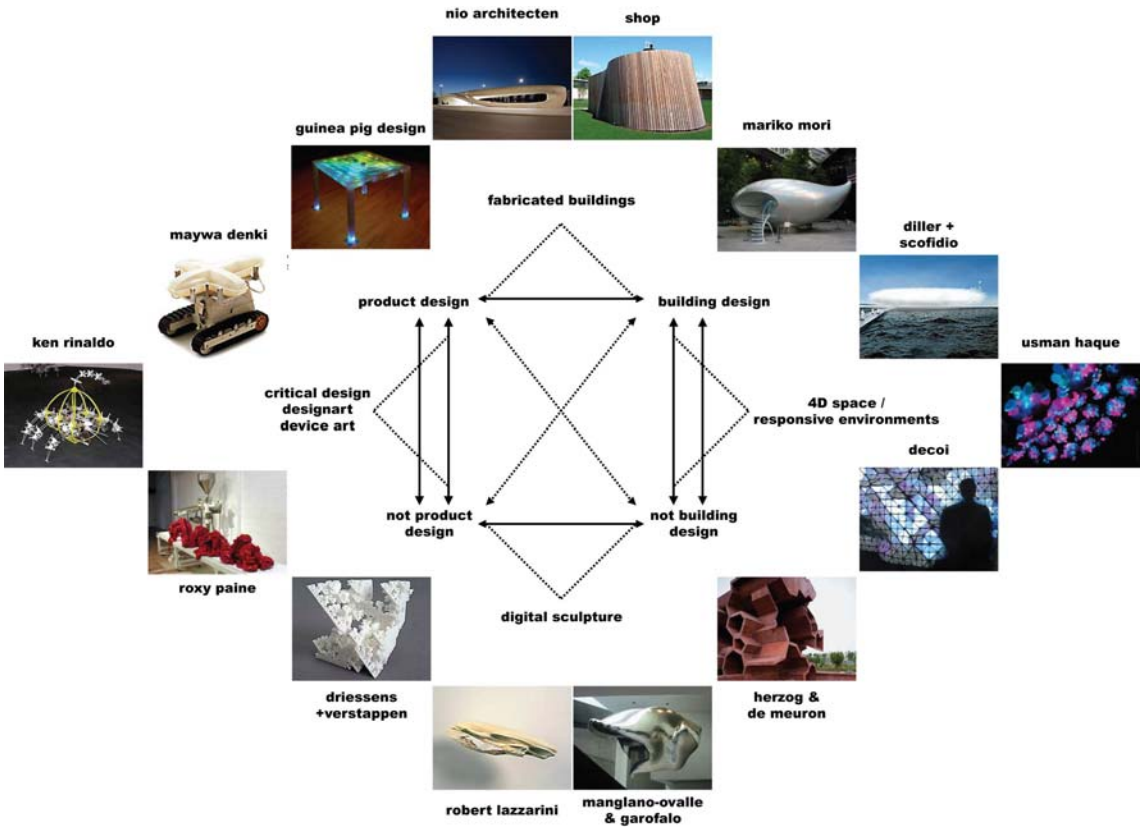

Figure 73: The updated 'Klein group' model used to structure objects from the field of enquiry

Through these few examples this new expanded field of designed objects suggests the opportunity to rethink models of practice driven by computer-based design and fabrication technologies. This concept of an expanded field is useful to establish a logical system across a broad range of objects that might otherwise be regarded as needlessly eclectic (see Figure 73). The research suggests that this system can not only be used to structure disparate objects from the field of enquiry but can also indicate relationships between the works shown in the 'PBB' exhibition (see Table 17 and Figure 74).

Practitioner	Title	Category	Type of Object
FutureFactories	Holy Ghost	DesignArt	Generative
Gavin Baily and Tom Corby	Cyclone.soc	Responsive Environment	Input-Driven
Adam Somlai-Fischer, Bengt Sjölén and Usman Haque	Wifi Camera Obscura	4dspace, Device Art	Responsive
Brit Bunkley	Sheep Jet Head	Digital Sculpture	Otherwise Unobtainable
Human Beans	What's Cooking Grandma?	Critical Design	Augmented
Justin Marshall	Penrose Strapping 1	DesignArt	Otherwise Unobtainable
Aoife Ludlow	Remember to Forget?	Device Art	Augmented
Ben Woodeson	Chicken Soup From Mars	Device Art	Augmented
Geoffrey Mann	Flight – Take Off	Digital Sculpture	Input-Driven
Simon Blackmore	LSD Drive	Device Art	Augmented
Tavs Jørgensen	Motion in Form	DesignArt	Input-Driven
Masaru Tabei and Yasuno Miyauchi	Ibuki - Presence in a Sigh	Device Art	Augmented
Simon Husslein	Warp	DesignArt, Device Art	Augmented
NIO Architecten	Watermark	Fabricated Building	Otherwise Unobtainable

Table 17: An indication of the relative categories applied to objects from the 'Perimeters, Boundaries and Borders' exhibition

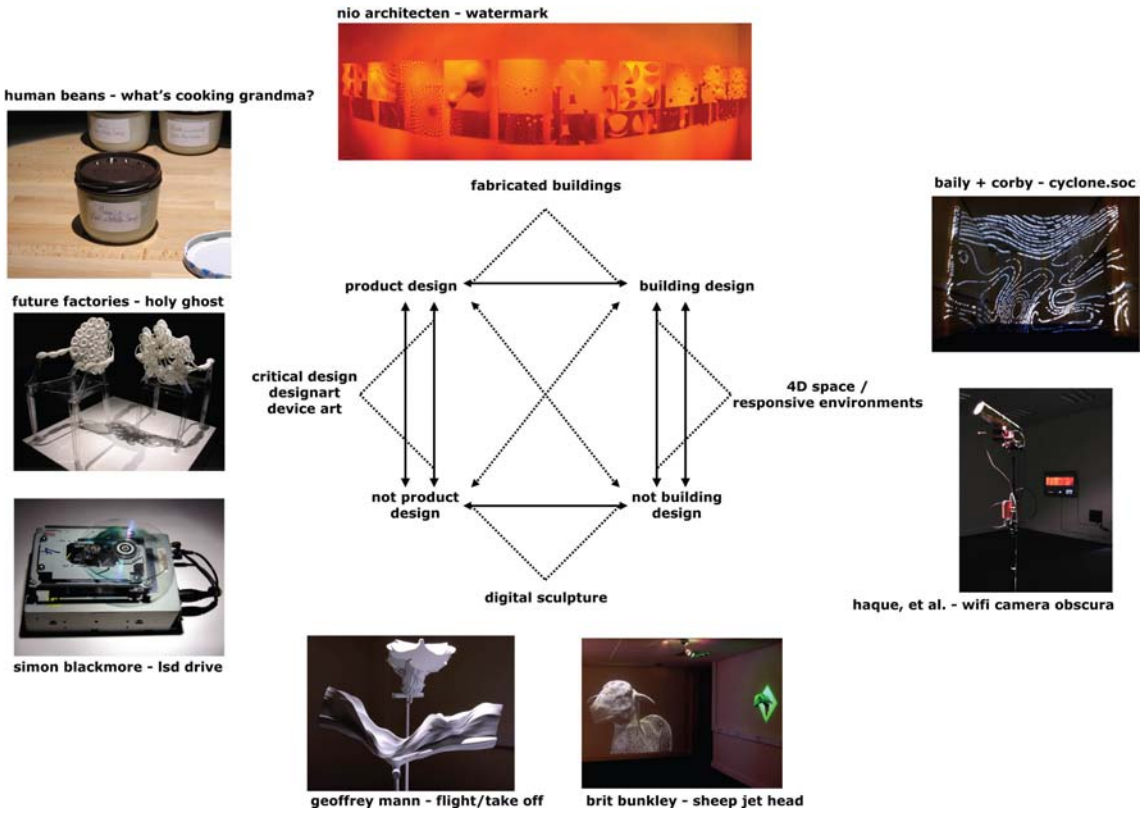

Figure 74: The updated 'Klein group' model used to structure objects from the 'Perimeters, Boundaries and Borders' exhibition

5.0 Discussion

This thesis has examined the use of various computer-based design and fabrication tools within a range of contexts. This enquiry has been situated within the context of use of these technologies becoming more widespread and experimental by certain practitioners. By focusing on the use of these digital tools this research has sought to explore if this shift to experimentation offers possibilities for a trend towards new forms of hybrid practice. The research has explored this territory through reviews of contextual and theoretical literature; a systematic analysis of a set of representative objects; the development of a curatorial brief for an exhibition and symposium; and by conducting surveys and interviews with practitioners and stakeholders in the field.

5.1 An engaged practitioner

Throughout the period of research the researcher has remained active as a practitioner in the field of enquiry. The researcher has been able to conduct this research because of his position as a practitioner and curator in this field. The researcher's role in the study has been participatory and the nature of the PhD project is that the research questions and propositions have been identified through this practice. This has enabled the researcher to gain a better understanding of the opportunities and challenges of the context within which this research is located.

5.1.1 Live Discourse

Blogs have become increasingly prevalent over the last few years. The use of a blog as a research method emerged throughout this study. It was not planned. The supervisory team was initially concerned the researcher was posting information about his research freely on the Internet long before it was printed in an academically accepted publication. With increasing access to information by means of the Internet, academic communication like all other forms of communication is changing. Connecting pieces of information is part of the work of research. For researchers that are making use of online sources a blog is suited to synthesising widely distributed knowledge and participating in discussions about it. It is an enhanced 'live' method of note taking. The research blog has been a useful method to disseminate information about the

research project and has contributed to increased professional esteem and an expanded network of colleagues for the researcher.

5.2 A critical review of designed objects

The aim of this process was to indicate common properties of objects and identify relationships between 'types' of objects. This was done to reveal an underlying structure of the field by grouping the objects into classifications. When considering computer-based design and fabrication tools and the range of objects that can be produced by them it should be borne in mind that any insight is primarily applicable to specific objects and circumstances. It is important to emphasise the extensive array of possible variables in computer-aided object-making across art and design disciplines that could have been studied. However, the nature of this study has been to try to find specific language and criteria that can be applied across the 3D art and design making disciplines. The research has revealed some suggestions for analytical and evaluative concepts that are indicative rather than conclusive.

It has been a goal of this research to demonstrate there is a significant body of existing exemplary projects that have common characteristics and can be recognised and understood across the discourse communities making use of computer-based design and fabrication tools. These 'boundary objects' can perform a brokering role involving translation, coordination and alignment between the disciplinary perspectives of specific communities of practice. However, these 'boundary objects' only provide us with a starting point by which to begin to distinguish and perhaps make determinations about types of hybrid art and design practice.

This study is framed in the context of histories of fabrication and the use of digital technologies as tools. By placing computer-based design and fabrication tools within the context of both traditional craft and mechanised mass production, we have seen how industrial manufacturing processes can be transformed into 'making' processes. It has been demonstrated that these tools have been appropriated for applications outside conventional manufacturing since 1968. The ability for practitioners to work across traditional disciplines and the possibility of a new hybrid model of 3D art and design practice was very

much part of the discourse of 'digital sculpture' since the 1990s. However, many of the practitioners engaged in this have produced 'remediated' objects (by using pre-programmed processes that allow any user to achieve complex, recognisable and reproducible results). The initial exposure of these technologies has been concerned with the mechanics of the digital tools and the subsequent critical discourse has been very limited. When we look beyond this 'digital sculpture' we find works that purposely exploit computer-based tools in ways that are more akin to how the technologies would be used in an industrial or commercial context. These works address the scope of both digital manufacturing and the arts. Some practitioners are also engaging in new models of disciplinary practice that exist alongside traditional models. The discourse around computer-based design and fabrication tools is most developed in architectural practice and these tools have become almost ubiquitous in this area.

With computer-based design and fabrication tools there is a trend towards a wider distribution of the means of production than has existed previously. The logical evolution of desktop publishing is 'desktop manufacturing' the ability to manufacture physical items directly from your computer desktop. Innovations are increasingly user-generated and tasks can be 'crowdsourced' to a large group of people usually by the Internet. New communities are developing around the appropriation and sharing of user-generated content and knowledge. This also implies new modes of consumption for the audiences, users and the co-creators of such objects. New production paradigms have brought producers and consumers into a closer relationship that has challenged conventional models of authorship as well as existing industrial and pedagogic models. Practitioners are exploring the boundary between computer science and physical science through 'personal fabrication'. 'Mass customisation' is consumer-driven, and makes use of technologies such as the Internet or databases to deliver personalised services through modularisation and reconfiguration. 'Design to order' inverts the conventional sequence of product development and manufacturing and 'individualised production' is a sign of discontinuities with both craft-based and mass-manufactured processes as we have known them so far.

The researcher created a theoretical picture of the field of study in the form of a database of one hundred and forty-eight objects. A formalised system of analysis was conducted on this to derive distinctive criteria and common properties from patterns that were observed from this process. The researcher formed groups of these objects around typological exemplars. Each object in the database was compared with these exemplars and assigned to the group that it most resembled. A schema was developed from this to examine the underlying structure of the field by grouping disparate objects into clusters. The value of this system has not been in creating new hierarchical relationships but in indicating common characteristics of objects and by identifying relationships between diverse 'types' of objects. These are not exhaustive but are representative of the criteria that were found to be applicable across disciplinary distinctions.

5.3 A survey of international practitioners

The purpose of this survey was: to develop an understanding of the current use of these technologies in art and design; establish how practitioners think about and engage with these technologies; and generate an understanding of how practitioners relate to and engage with other art and design disciplines. The selected practitioners represent a spectrum of practices from across disciplines and from a wide range of approaches to their use of computer-based design and fabrication technologies. This includes both emerging practitioners and well-established, exemplary practitioners.

The main aim of this survey was to prompt practitioners to think and reflect on their engagement with computer-based design and fabrication technologies and with other art and design disciplines they consider are related to or relevant to their practice. The survey sought to form an overview of current activity by practitioners in the area of enquiry. This allowed the researcher to establish a baseline of contemporary practice against which to frame the context for the wider study. The responses gathered were helpful in suggesting and unpacking terms and notions around which distinctions in the field of enquiry could be derived.

From the responses received slightly more practitioners indicated they were engaged with more than one discipline than had been expected by the researcher. This might indicate they think of themselves to have a cross-disciplinary practice. However, the nature of how this may manifest is not answered definitively by the data gathered in this survey. This indicates an opportunity for more rigorous analysis through future research.

Rapid prototyping, 3D modelling and 3D printing were indicated as the most commonly used computer-based design and fabrication technologies. Nearly all the practitioners pointed out that when it came to using these technologies they were self-taught. Their experience had come through task-related or project-based engagement with the technologies. For these practitioners computer-based design and fabrication tools represent an enhancement of traditional methods and should not be viewed as a total replacement for them. The survey indicates there is no alternative to 'hands on', iterative experience when approaching these technologies. This has widespread implications (particularly within education) when it is considered the primary limitations regarding the use of these technologies were identified as resource issues. The implications for student designers are as prescient as they are for educators facing the challenge of how to integrate these technologies into the curriculum. Access to equipment, constant software and hardware upgrades and the availability of qualified technicians were all mentioned as impediments with cost repercussions.

Future work is necessary to explore the nature of audiences for these types of objects. The primary means of engagement were indicated as being through exhibitions, education and as research papers and presentations. However, it was clear from the responses from practitioners that not much else is known about this. Also, it would seem that although many practitioners consider themselves to be involved in cross-disciplinary forms of practice the communities they engage with actually have a narrower, more disciplinary focus. This indicates a series of 'ghettoised' communities that recognise the potential to communicate with each other but that do not.

The survey provided a substantial foundation from which to proceed at the time it was conducted. As a first stage of research in this area it helped to define the scope both theoretical and practical within which subsequent work operated within. Most importantly this survey indicated that indeed there were commonalities in the underlying approaches and interests of individual practitioners.

5.4 Development of a curatorial framework

The general idea of the curatorial framework for the 'Perimeters, Boundaries and Borders' exhibition was to try to set a new threshold by the quality of the work and critical engagement than had been done by the researcher previously. The exhibition was to contain a mixture of existing works (selected from an open call process) and new works (from practitioners selected and invited to participate in relation to the curatorial theme/brief). The researcher's initial intention to commission new works as part of this exhibition and move away from the 'Intersculpt' model by making partnerships with another organisation (folly) was achieved. Also the funding raised through ACE, MIRIAD, and Lancaster City Council was approximately double that raised for 'Intersculpt:uk 03'. The project partners welcomed the discussions we had through the curatorial meetings and responded positively to there being a clear goal for the exhibition from the outset.

We were able to attract a wide range of regional, national and international practitioners through the open call process which was represented in the final selection of works. Forty-six practitioners applied for the open call. This is one less than applied for the previous exhibition ('Intersculpt:uk 03'). Most of the practitioners that applied for the exhibition did so because they felt the multidomain aspect of the exhibition related to what they were working on at the time. This indicates there are a sufficient amount of practitioners currently working that consider their work to 'blur the conventional boundaries of arts and design practice'. However, no practicing architects responded to the call. Beyond the most obvious issue of the limited budget, it is not clear why this was the case and further work (perhaps conducted from within the discipline) would be welcome in this area.

5.5 A public exhibition and symposium

It was intended that through conducting a public exhibition the researcher would:

- obtain access to specific qualitative information from a sample of contemporary practitioners
- obtain general information relevant to this thesis
- gain insights by recording and making comparisons between qualitative statements made by participating practitioners

These events also allowed the researcher to survey existing works, explore future trends, gather audience and peer responses and engage the broader community of interest around the field of enquiry.

Twenty-two works in total were exhibited. Fast-uk funded four new commissions and exhibited eighteen existing works. These existing works (from fourteen sets of practitioners) were selected from a pool of forty-six applicants. Because of the quality of artistic participation we were able to increase funding received from MIRIAD and raised partnership funding from folly and Lancaster City Council[131]. Lancaster City Council allowed the use of CityLab free of charge (the entire ground floor of the building was leased by new tenants during the exhibition and they (LCC) were thrilled with this result).

The researcher acknowledges the choice of venue had major implications for the exhibition. During the three weeks of the exhibition there were 593 visitors to the exhibition (630 including those that also attended the symposium). The number of visitors was lower than anticipated. Part of this has to be because the available audience in Lancaster and the nature of the exhibition venue. This was offset by a higher than expected amount of interest online. There were 3,641 visits to the Fast-uk website and over 12,500 visits to the folly website during that same three week period. However, because the exhibition was not staged in an established gallery in Manchester (as originally intended) this also had implications on the work that could be shown. Two practitioners selected for commissions withdrew from the exhibition because the venue was not an established gallery. The researcher had not foreseen this effect.

[131] The total project budget was £64,813 in cash and in-kind contributions. £30,000 was secured from ACE and £5,000 from MIRIAD.

The number of critical reviews of the 'PBB' exhibition was disappointing. The fact the exhibition was in a creative industries centre in Lancaster most likely played a role in this. However, the researcher views the fact that Tavs Jørgensen's 'Motion in Form' glass bowl forms were featured on Rhizome.org (an online platform for the global new media art community) as one of the major accomplishments of the exhibition. The nature of these objects is so rooted in traditional craft practice the fact they would be of interest to this community was surprising. This stands as an indication that innovative production methods can provide alternate standards to established discourses. In terms of key achievements the new partnership with folly was one of the most successful aspects of this programme of events. Issues that arose were resolved to Fast-uk's satisfaction in a timely manner. For example, during the period just before the show was due to open communication between Fast-uk and folly ran into some difficulties and the researcher had to remind folly that as the primary source of funding for 'PBB' Fast-uk wished to be credited as per the consultant's agreement for project management. This issue had arisen due to the rapid expansion in folly personnel after the project had already begun (compounded by the roles of 'partner' and 'consultant' being blurred). In general however, the proactive attitude, enthusiasm and professionalism of folly's staff were a major contributing factor to the success of the exhibition, symposium and workshop.

The researcher had also attempted to create links between the project and Lancaster University. To this end the researcher prepared a grant application to the AHRC Case for Support fund for the 'PBB' symposium and a catalogue (Marshall, 2008) for the exhibition. However, there was no institutional support for this application from Lancaster Institute for the Contemporary Arts (LICA) and it was abandoned. We considered it a loss to the project and a missed opportunity that Lancaster University was not involved.

5.5.1 Symposium

The 'Perimeters, Boundaries and Borders' symposium (see Appendix I for transcript) brought together artists, designers, architects, craft makers, academics, students and others to talk about the 'PBB' exhibition and discuss how computer-based design and fabrication tools have impacted on creative practice and production methods. Those in attendance heard about changes

now faced in the design-related field of practice. These changes were categorised by Paul Rodgers as professional, economic and technological. It was also claimed that computing technologies have enabled practitioners to transcend what have historically been seen as distinct and separate disciplines.

The material aspects of making were highlighted as crucially important throughout the presentations by practitioners whose modes of practice can be defined by the use of computer-based tools. Many practitioners are actively working on ways to combine the two methods. Speculation and concern was expressed about the implications of a purely digital practice, especially for the next generation of practitioners. A paradox was identified in current education between the need to learn about materials whilst also building knowledge of technologies that allow you to make objects without ever touching the physical matter until the end of the process. Nevertheless, there was a sense of unease for some about the potential effectiveness of hybrid, material/digital degrees. The practitioners indicated the time involved in acquiring skill or knowledge with computer-based tools and the cost of this were limiting factors. However, it was also pointed out the availability of inexpensive or free software has enabled new forms of cultural literacy and new genres of output in the area of digital video and photography. This led to speculation about the potential impact of the proliferation of small scale manufacturing and customised fabrication as these technologies become more affordable and accessible.

Some of the practitioners indicated they were exploring the possibility that new forms of digital production could create more sustainable forms of practice and new economic opportunities. Many of those present were attracted to the flexibility that computer-based design and fabrication tools brought to their working methods and the closer relationship to their audience that resulted from this. It was pointed out that often the introduction of computer-based tools to traditional, materials-based practice changed the nature of what the practitioner's practice was. It was also suggested that technology is breaking down the barriers between traditional practices. However, it was asserted that a distinct, domain-specific mindset was more prevalent in the UK than other nations. This would make an interesting subject for a future study.

The practitioners articulated ways in which the computer operates both as a medium and as a tool. But a critical distinction was made - that the systems and rules that control the tools are more of a medium than the 'programmed-in' suite of modelling tools available in any application. Some of the practitioners identified that they were making use of software and hardware as a generative means of increasing the opportunity for new modes of design practice, new production paradigms, design vocabularies and methodologies. There was also a call for new terms to describe the work that is being made and new critical frameworks to evaluate and understand it by. Most of those that attended thought the symposium provided valuable insight into the topic and that the quality of speakers was good. The majority of those that responded to the evaluation survey of the event indicated they would be interested in attending similar symposiums.

5.5.2 Practitioner interviews

Six practitioners from across the 3D art and design making disciplines whose work was included in the 'PBB' exhibition were interviewed. The main aim of these interviews was to examine:

- their expectations of the exhibition
- their actual experience of the exhibition
- any impact the exhibition had on their thinking and their practice

The main aim of these interviews was to examine similarities and differences between the practitioners' experiences and to solicit their reflections on the exhibition. These post-exhibition interviews offered an opportunity to capture participant-practitioner's qualitative opinions and allow for issues to be raised that might not be immediately obvious otherwise. The researcher hoped to determine if the participants thought the exhibition was representative of the direction that art and design practitioners are taking towards computer-based design and fabrication tools.

Analysis was made of the data gathered from these interviews to reveal issues for individual practitioners and indications of patterns or themes relevant to the theoretical framework of this study. Two thirds of the practitioners had applied for the exhibition because they felt the multi-domain aspect of the exhibition related to what they were working on at the time. Half of the practitioners saw

the exhibition primarily as a means to show their work while another third saw it as an opportunity to network with other practitioners. In general, they felt the range of practitioners in the exhibition was broader than they had expected.

Most of the practitioners stated the exhibition lived up to or exceeded their expectations. However, most of the practitioners considered the venue (being an office space) was the one aspect they were not satisfied with. Conversely, the practitioners considered the atmosphere and physical appearance of the show, the diversity and surprising nature of the work was what they most liked about the exhibition. The fact the exhibition was not a major metropolitan centre was the exhibition's most negative aspect for a third of the interviewees. Some visitors would have liked more information on the technologies and processes behind the works in the exhibition. Most of the practitioners suggested that this contextual information would have been appropriate for some works. They indicated that this information ought to be optional and should not be too technical for a general audience.

The researcher asked what impact the exhibition had in professional terms for the practitioners. Most considered they had made new professional contacts and half of them had their work featured in publications because of the exhibition. Two thirds were aware the exhibition had increased traffic to their websites. Two practitioners considered that participating in the exhibition had had an effect on their work and another indicated they expected it would in the future. All the practitioners answered they would participate in another exhibition like 'PBB'.

To grant further insight about how these practitioners understand their use of computer-based technologies the researcher asked them the technology-related questions from the previous survey of practitioners. In general their responses corroborated the findings of the previous survey. All the practitioners pointed out their practice had been transformed by computer-based technologies. In addition, a third of them stated the nature of their practice was defined by the use of these technologies and others indicated that use of these technologies had changed how they think about or see the world. This idea of a practice defined by the use of technology is an important distinction for this study.

The researcher asked a series of questions of the practitioners about the relationship between their practice and other disciplines. Half stated their practice was contingent on the context in which they were working at any given time. The rest identified their practice as a relationship between two or more domains. However, only two of the practitioners were definite in their support of the proposition of a trend towards an emerging, hybrid discipline. The practitioners were more confident in supporting the notion that technologies were increasing opportunities in this prospective area.

5.5.3 Audience survey

Twenty-eight visitors to the 'PBB' exhibition completed a questionnaire they were asked to fill in by an invigilator as they left the exhibition. This survey was a combination of questions posed by folly and by the researcher. The number of completed questionnaires represents 4.7% of the total visitors to the exhibition.

Half of the visitors that responded to the questionnaire had attended the exhibition because it had been recommended to them. Four people had come because they wanted to try something new. Two had visited it to find out more about the practitioners that were featured in the exhibition. Most of the surveyed visitors thought the exhibition was easy to find. However, one person indicated they had found it difficult. All those that responded found the exhibition informative and interesting.

Visitors thought the signage and interpretive materials available in the exhibition were useful and appropriate. During the exhibition the upper floors of CityLab continued to function as a commercial office space. Some visitors thought there could have been better indication of how to get to the exhibition from the CityLab lobby. This was done by a door directly opposite the main entrance. An attempt to address this was made with additional signage after the exhibition had been open for a while. It was pointed out that visitors had not always been greeted at reception and some had found this intimidating. Nearly everyone indicated the volunteer invigilators were polite, friendly and knowledgeable. However one person had found them overbearing and considered this the most negative aspect of the exhibition.

Four visitors indicated the diversity and variety of works in the exhibition was the feature of the exhibition they most liked. Another four pointed to aspects of the way the exhibition space had been set up as most satisfying for them. However, almost a fifth of those surveyed mentioned characteristics of the venue as their least favourite quality of the exhibition. Four visitors were dissatisfied with the information available and one suggested the opening times were inconvenient for them.

5.5.4 Partner interviews

The researcher conducted interviews with two representatives of partnering organisation folly that had been involved throughout the management of the project and had participated on the curatorial panel for the 'PBB' exhibition. The main aim of these interviews was to examine:

- folly's expectations of the exhibition
- folly's experience of the exhibition
- any impact the exhibition had on folly

Analysis was made of the data gathered from these interviews to reveal issues and indications of patterns or themes relevant to the theoretical framework of this study. 'Perimeters, Boundaries and Borders' was considered to have supported and extended folly's mission. It was an opportunity for the organisation to adopt a 'design agenda' that had not been represented in the work they had done so far. The exhibition provided a type of experience for their audience that was not just screen or web-based but was physically manifest in objects. The exhibition was considered as a hub around which they were able to build the wider f.city Festival of Digital Culture. Slight concerns were expressed the exhibition had skewed audience perception of folly's mission and they would expect more product and exhibition-led activity from them in future. During the project the collaborative website (wiki) the researcher set up to be used by the members of the project team had been useful in coordinating between the project partners and it proved a useful tool to indicate the potential 'look and feel' of the exhibition.

folly welcomed the collaborative nature of the curatorial selection process but acknowledged the overall vision was set by Fast-uk. Only half of the works in the exhibition were within folly's traditional remit. However, this was

considered to be a strength and a positive outcome of the partnership. The exhibition had lived up to the partners expectations of it but it had been hoped that more architects would have participated.

folly acknowledged the limitations of the exhibition space in terms of visual appearance and accessibility to the public. To try to offset this extra effort had been made with signage to encourage visitors to explore the building. The reception area of the building was identified as a barrier to attracting casual visitors to the exhibition. This could also have been addressed with a different marketing strategy to draw more of an audience. The visitors the exhibition did receive spent longer than any previous exhibition folly had presented (an average of 45 minutes) and it was suggested that a space where they could have sat and accessed additional information would have been of value.

The sensibilities of the exhibition were considered to be based in design and it was thought to be representative of the diversity of 3D 'technology-led-practice'. The atmosphere in the exhibition felt lively and active and folly was proud of how ambitious it was in scope. The most negative aspect of the exhibition was the fact the venue was a commercial office development and this had impacted on the accessibility of the space to the public.

folly reported that members of the local community had a better understanding of what it was that folly did because of the exhibition and had a sense of pride the exhibition had taken place in Lancaster rather than a major metropolitan city. Local organisations had responded positively but the exhibition had struggled to draw folly's peers from the wider region. This could possibly have been addressed by keeping the exhibition open for longer on the weekends. The City and County Councils and Arts Council England were positive about the scale and ambition of the exhibition. In addition, the exhibition had allowed folly to expand the number of volunteers willing to work with the organisation.

folly's involvement in the exhibition is likely to focus the curatorial vision of the organisation more around tangible projects in future and they are more likely to solicit work from open calls and actively participate in the development of new works because of this experience. folly would like to develop the partnering

model rather than the service provider model in delivering future projects based on the lessons-learned through this project.

5.5.5 Press citations

As stated previously, the number of reviews of this exhibition was disappointing. The fact the exhibition was in a creative industries centre in Lancaster most likely played a role in this. In the case of the articles for Rhizome and Generator.x by Michelle Kasprzak and Marius Watz the same article has been counted more than once as they were reposted by different online discourse communities. The purpose of collecting the press citations is to note the disciplinary perspectives that regard works to be of interest. In the following (Table 18) it is noted whether a practitioner's work is mentioned. This allows us to see which works that were most discussed and by which communities.

Practitioner	Citations	Interest
FutureFactories	8	general, design, industrial design, new media art, regional, generative art and design, art and technology, art
Gavin Baily and Tom Corby	7	new media art, network-enabled practice, new media art, regional, generative art and design, art and technology, art
Adam Somlai-Fischer, Bengt Sjölén and Usman Haque	4	art, design, technology, futurism, gadgets, human-computer interaction, computer-aided visualisation
Brit Bunkley	4	general, local, new media art, regional, art
Human Beans	3	new media art, regional, general
Justin Marshall	3	generative art and design, art and technology, new media art
Aoife Ludlow	2	new media art, network-enabled practice
Ben Woodeson	2	new media art, regional, art
Geoffrey Mann	2	art
Simon Blackmore	2	art, design, technology, new media art, regional
Tavs Jørgensen	2	new media art, network-enabled practice
Masaru Tabei and Yasuno Miyauchi	1	new media art, regional
Simon Husslein	1	new media art, regional
NIO Architecten	0	-

Table 18: Which works were most cited and by which discourse communities

Perhaps the most striking aspect of this is the interest shown in Human Beans and Tavs Jørgensen by the new media community. Previously, Human Beans' practice was located within a (critical) design discourse. They were surprised[132] even to have been invited to participate in 'PBB'. The subsequent inclusion of this work in the exhibition 'My Own Private Reality' at the Edith Russ Site for Media Art is a significant indication there is now broader interest in their work. As stated above, the review of Jørgensen's work on Rhizome.org was the most surprising thing of all. 'Motion in Form' was the most traditional-looking work in the exhibition. Many visitors did not make a connection to computer-based technology when viewing the glass bowl forms and these works were indicated as among the works least fitting the artistic vision of folly. It should not be overlooked that Michelle Kasprzak who wrote the 'Prototyping the Perimeters' review attended the symposium and therefore saw the video of Jørgensen using the ShapeHand™ motion capture system. Nevertheless, it is encouraging that perceived boundaries between discourse communities were crossed by these works. This is an indication that innovative production methods can provide alternate standards to established discourses.

The few references to Geoffrey Mann's work and no references to NIO Architecten's work is also surprising. 'Flight – Take Off' was the second most popular work in the audience survey and received much positive attention from visitors. However, this did not translate into press interest for 'PBB'. NIO's work was not cited at all. The panels that were produced for the exhibition were dependent on the accompanying slide presentation to try to explain what their purpose was. Out of context the panels themselves were just not very interesting. This was reflected by the lack of press references to this work.

5.5.6 Summary of public exhibition and symposium discussion

Through the process of organising a public exhibition and symposium the researcher was able to gather qualitative information from a sample of contemporary practitioners, survey existing works, explore future trends, gather audience and peer responses and engage with the broader community of

[132] "It's still a bit of a mystery to us how we got selected for this show… Can you shed any light on this?" From an email received 24/08/2006. The researcher had seen an article on them in I.D. Magazine, April, 2002 and had been following their work since.

interest around the field of enquiry. The exhibition was successful in attracting partnerships with professional bodies and in receiving public funding. The partnership with media arts organisation folly was a major contributing factor to the success of the exhibition and symposium. folly's involvement in the exhibition is likely to change how the organisation operates in future.

Members of the audience indicated the diversity and variety of works in the exhibition was the most successful aspect of the exhibition. The exhibition attracted greater interest online than had been expected but fewer actual visitors than had been anticipated. A plausible explanation of this because the exhibition was in Lancaster rather than a major metropolitan city - as had been originally intended. Unfortunately, this also meant that practitioners selected for the exhibition withdrew. From a position of hindsight this should not have come as such a surprise to the researcher.

It was disappointing that Lancaster University was not involved in the exhibition or symposium. The summer break and resulting absence of academics prevented appropriate relationships from being built. Beginning this process earlier might have offset these difficulties. However, at the time it was thought that it was important to have an overview of what was on offer before seeking institutional support.

The initial research questions and propositions for this study were identified through the researcher's practice as a practitioner and curator in this field. Since the researcher sought to assess current activity in the field of enquiry within its real-life context, the exhibition and symposium enabled the researcher to gather and make observations about the nature of the relationships between practitioners, disciplines, tools and the types of objects being produced by using computer-based design and fabrication technologies. However, this research is also reflexive - it has actively contributed to the construction of a context for the exhibition participants. Many of the practitioners involved in the exhibition indicated they had made new professional contacts and had received wider exposure for their work because of the exhibition.

This research aimed to demonstrate a significant shift in the thinking of practitioners that make use of computer-based tools towards a hybrid model of art and design practice. The idea of a practice defined by the use of technology was an important distinction made through this study. Participants in the exhibition and symposium stated the nature of their practice is defined by the use of these technologies. Nevertheless few practitioners supported the proposition of an emerging, hybrid discipline. However, practitioners were confident in supporting the notion that computer-based design and fabrication tools were instrumental in creating expanded opportunities for them. These are valuable insights that contribute to a general theoretical understanding of and an indicative snapshot of the field of enquiry at the present time.

5.6 Development of analytical models

To draw distinctions between projects across disciplinary boundaries the researcher has been working on proposed models of the relationships between:

- the integration of computer-based technologies and the objects produced by practitioners using them
- various types of cross-disciplinary or hybrid art and design practice

It was intended these will allow the researcher to present the findings of the study and develop the critical language, criteria and framework of analysis within a wider context. More work is necessary to make these models generally applicable. We must consider how viable it is to extract criteria from an analysis of existing objects produced under different circumstances and for various purposes both commercial and non-commercial. It can be argued the defined criteria are not unambiguous. The current work only addresses this from a pluralist perspective. Further collaborative work is necessary from within each disciplinary perspective to generate a more universally applicable system of categorisation. The models presented in this study are offered up to be adapted and built upon.

5.6.1 Technology adoption models

As previously stated by Harrod (2002) and Lynn (Lynn and Rashid, 2003) the introduction of new technologies can disrupt and therefore change the way practitioners perform tasks. What was needed was a particular model of the typical patterns that practitioners go through when integrating these

technologies into their practice and whether there is any indication that this might yield a greater integration between cross-disciplinary fields of enquiry. A suitable model would not be categorised in terms of time but rather defined by increased levels of integration of these technologies towards the development of new orders of object (as described in section 3.6.1).

Compacting the five ACOT phases ('Entry', 'Adoption', 'Adaptation', 'Appropriation' and 'Invention') into three stages ('Entry-Adoption', 'Adaptation' and 'Appropriation-Invention') led to a greater objectivity in this process. Trying to make distinctions between the 'Entry' and 'Adoption' stages; and the 'Appropriation' and 'Invention' became too subjective. By limiting the number of categories the adoption model is less specific but potentially more useful. Nevertheless, again this classification system should be viewed as indicative rather than conclusive. This is an area that would benefit from future work of a more empirical nature being conducted.

5.6.2 Klein group model

The researcher's development a contemporary version of Rosalind Krauss's 'Klein group' model has offered a means of visualising the terrain of the field of enquiry within which the researcher's practice is located. This system was used to structure both objects from the field of enquiry and also the works shown in the 'PBB' exhibition. This was not done to define finite categories but to map and make sense of existing developments across the art and design disciplines within which the researcher's practice is located. There are other possible starting points and possible expansions but the one presented in this study attempts to make sense of the researcher's practice as set out in section 1.1. Interesting future directions for this research would consider if this method can help identify emergent research areas for practitioners as well as mapping existing objects.

The researcher used the category of 'digital sculpture' as that which is 'not product design' and 'not building design' as a starting point. This was expanded to include the implicit relationship with 'product design' and 'building design'. From this the researcher indicated three hybrid forms of practice that this conjunction makes evident (see Figure 72):

- the conjunction of 'product design' and 'architecture' as 'fabricated buildings'.
- the conjunction of 'product design' and 'not product design' as 'critical design', 'designart' and 'device art'
- the conjunction of 'building design' and 'not building design' as '4dspace' and 'responsive environments'

'Fabricated buildings' are a new order of object that makes use of computer numerically controlled (CNC) fabrication to generate construction information directly from design information. 'Critical design' (Dunne, 1999) makes use of designed objects as a form of material commentary in a cultural context. 'Designart' (after Coles, 2005) is any of several speculative types of objects produced reciprocally somewhere in-between art and design. 'Device Art' (Kusahara, 2006) is a concept for re-examining the relationships between art, science and technology as a form of media art that integrates art and technology as well as design, entertainment, and popular culture through mass production and commercial distribution. '4dspace' (Bullivant, 2005) explores the use of various technologies such as sensing mechanisms as a 4th time-based dimension and 'responsive environments' (Bullivant, 2006) interact with the people who use them.

6.0 Conclusions

This study came about through a wish to examine the expanded context of the researcher's practice. The basic argument developed in this thesis is that an increasing number of practitioners are able and willing to negotiate working across previously designated disciplinary domains through the use of computer-based design and fabrication tools. The research set out to show a significant shift occurs in the thinking of practitioners that make use of computer-based tools. The research proposition was that this enables a trend towards a hybrid model of art and design practice. This section critically discusses the research questions, methods and the practicable and theoretical implications the outcomes might have for future practice.

This thesis has made a detailed exploration of a hybrid approach to making 3D objects with computer-based tools. A specific interest that emerged for the researcher was the mechanisms and repercussions of the integration of technological developments that are migrating from industrial manufacturing to the practices of individual art and design practitioners. A primary aim of this was to establish a clearer understanding of the use of these tools within art and design practice. A secondary aim was to evaluate the work happening across traditional disciplines. A goal for this research that emerged was to demonstrate there is a significant body of exemplary 'boundary objects' that can be recognised and understood by the discourse communities that comprise the community of interest for this work (see section 2.8.3).

6.1 Context

The research began with a contextual review that considered the historical use of these tools in object-making within art and design practice (see section 2.2). It also explored the types of objects produced by practitioners from across the fields of art and design (see section 2.3.1) and the theoretical discourse around this activity (see section 2.4). The review identified several forms of art and design practice that involve hybridity between traditional disciplines (see section 2.9). It indicated a need for models of practice and critical language to discuss the relationship between these forms of practice and the objects produced by them (see section 2.10). The review showed that use of these tools does affect the thought processes of practitioners (see section 2.4). It also

demonstrated a need for greater understanding of how practitioners are facing the creative possibilities that visual computing offers in challenging the way that art and design practitioners can work (see section 2.7).

There is an increased recognition of the impact of creative practitioners in the wider economy (see section 1.2). The cost of computer-based tools has decreased and specialised engineering training is no longer a precondition of their use. This has resulted in increased access to digital technology for a more diverse range of practitioners. Tools based on the use of cheap, readily available computer equipment are enabling and accelerating new forms of innovation by 'lead-users' (see section 2.7.6). This has created new business models and cultural opportunities (see sections 2.7 and 2.9). Online social networks are transforming how objects can be designed, manufactured, and distributed. For example, an Open Source approach has been applied to physical things that allow users to improve and redistribute objects as computer models and sets of instructions for their construction (see section 2.7.7). An intrinsic aspect of this is the development of new ways of approaching practice, including a reformulation of the relationship between consumers and producers (see section 2.9.5). The contextual review identified forms of art and design practice that can be described as 'hybrid'. This required the definition of terms to discuss the relationships between these 'hybrid' forms and the objects produced by them. This in turn suggested a need for a more systematic evaluation of this cross-disciplinary work.

6.2 Methodology

The research applied a methodology designed to create a clearer understanding of the work of individual practitioners with an established digital practice. This focused on objects produced over the last ten years but placed particular attention on work that is being created by a form of practice that can be characterised as a 'hybrid' product of both art and design disciplines. The study made use of a systematic analysis of archived data to reveal the underlying structure of this field by grouping objects into indicative classifications. This formed the basis of a set of terms to describe these types of objects (see section 4.2.1). A curatorial framework for a public exhibition and symposium was developed around these types of objects (see section 4.4). Primary research in

the form of surveys and interviews with practitioners, stakeholders and audiences was undertaken (see sections 4.5.4, 4.5.5 and 4.5.6). Insights from practitioners were gathered as case studies to establish a clearer understanding of the use of computer-based tools and provide a means to evaluate the work happening across traditional disciplines. Models were constructed to describe the adoption of computer-based design and fabrication tools by practitioners (see section 3.6.1) and to indicate the field of practice that shows a greater integration between art and design disciplines by using these tools (see section 4.6.2). The research was designed to enable the researcher to draw broad conclusions about the nature of the relationships between practitioners, disciplines, tools and the types of objects being produced.

6.3 Questions

The specific questions addressed by this research were:

- Are there new kinds of objects being produced by art and design practitioners using computer-based tools?
- What are the significant characteristics of these objects and are there specific criteria which can be used to identify these new kinds of objects?
- Is there a trend towards a hybrid model of art and design practice emerging out of the use of computer-based tools and if so, what implications might this have for future practice?

This study offered analytical terms to make distinctions between projects that can be applied across disciplinary boundaries. The contextual review, systematic analysis of archived data, surveys and case studies revealed there are new production paradigms, design vocabularies and new orders of object being produced. Six distinct kinds of object were determined from significant characteristics of these objects, based on indicative classifications formed around typological exemplars. Three of these categories were based on the functional capabilities built into the objects and three based on the means by which they were created:

- 'Augmented objects' have some kind of embedded technology that performs one or more predefined tasks.
- 'Autonomous objects' contain some means of independent control.
- 'Generative objects' have been designed by using algorithms that can evolve structures and objects based on predetermined rules, conditions and variables.
- 'Input-driven objects' are characterised by the technology used in their creation.

- ‘Otherwise unobtainable objects’ have qualities that are unlikely to be achieved without the aid of a computer.
- ‘Responsive objects’ incorporate technologies such as sensing mechanisms or dynamic media systems and interact with their audience or users.

The value of this system is its applicability across disciplinary distinctions. Specific technologies are not indicated and the definitions do not suggest any particular scale or intent for the objects. These objects can be considered ‘boundary objects’ (see section 2.8.3) that provide a means of coordination between the various communities of practice that make up the community of interest addressed in this study. This work shows there is a significant body of existing exemplary projects that can be recognised and understood across these discourse communities.

The researcher gathered information that showed practitioners are working in many different contexts, at different stages of technological integration and with different levels of available resources. Many practitioners that were contacted indicated their practice had been transformed by computer-based tools. Some went as far to state the nature of their practice was now defined by these technologies. This new characterisation of a ‘technology-led-practice’ can apply to both discipline-based and extra-disciplinary modes of practice. However, there are some clearly observable trends which can give a picture of transitions from conventional models of practice towards characteristics of a ‘technology-led practice’ (Table 19).

From	To	Reference
Expensive Technology	(More) Less-expensive Technology	(see section 2.1)
Manufacturing	Making	(see section 2.1)
Centralised Design	Distributed Design	(see section 2.7)
Standardised Production	Personalised Production	(see section 2.7)
Disciplinary	Transdisciplinary	(see section 2.8)
Communities of Practice	Communities of Interest	(see section 2.8.3)
Tools for Productivity	Tools for Experimentation	(see section 2.6.1)
Artists or Designers	Hybrid Practitioners	(see section 2.9)
Aesthetic Contemplation	Interactivity	(see section 2.9.5)
Parts	Systems	(see section 4.2.1)

Table 19: Observed trends from conventional models of practice towards characteristics of a 'technology-led practice'

These 'technology-led practitioners' are actively investigating and exploiting computer technologies to achieve innovation. The research has shown there are practitioners working that consider their work to 'blur the conventional boundaries of art and design practice' (see section 4.4). However, the practitioners contacted for this study were not definite in their support of the proposition that this represents a trend towards a new hybrid art and design discipline. Although they would support the notion that computer-based tools were increasing their opportunities for a more economically sustainable practice.

This study proposed that collectively these practitioners working across disciplinary 'perimeters, boundaries and borders' might form a community of interest that shares a common technology-based discourse that exists in the space between conventional, creative disciplines. The researcher has pointed to computer-based tools as the basis for a 'Lingua Franca' - a common language - through which a synthesis of formal vocabulary, methods and knowledge can happen for these practitioners. The research has presented how the artifacts made by these practitioners - as 'boundary objects' - can perform as a means of coordination and alignment across disciplines and as a means of translation between them. The work happening between disciplines has also been shown to

act as a reflexive space to understand, critique and change the dominant discourses and nature of practice for the conventional disciplines (see section 2.9.7). Collectively, these might represent an expanded cultural field beyond each of the traditional disciplines.

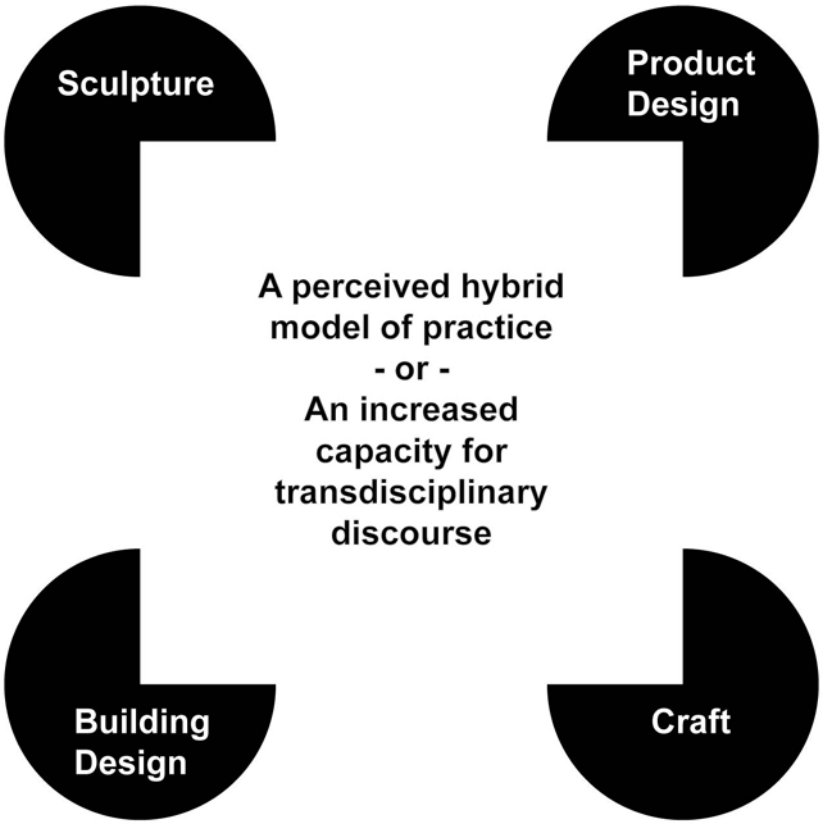

Figure 75: Traditional art and design disciplines provide the background to a new hybrid model of practice

The diagram above (Figure 75) is called the 'Kanizsa Square'. One way of interpreting this optical illusion is that it is four black circles each with a quarter removed. Another is of a white square in front of four black circles. This shows how the researcher makes sense of this field of enquiry based on the insights gained from this study. The traditional art and design disciplines provide the background to this perceived field (a new hybrid model represented by the imposed white square) of the current area of enquiry. However, this new model of practice is dependent on the conception of these traditional disciplines (it supplements but doesn't supersede them). If you were to remove one you would no longer be able to locate (critically or culturally) the hybrid model of practice. The new models of practice proposed in this study represent the clustering of a multitude of practices now emerging. There is significant evidence of an

increased capacity for a transdisciplinary discourse at the intersection of these disciplinary domains. Computer-based design and fabrication tools form a basis by which to facilitate this transdisciplinary discourse.

6.4 Critical review of methods

An asset of this research is the breadth of practice, literature and primary sources which contribute to its findings. The study provides a description of the expanded context of the researcher's practice as a qualitative case study. This thesis has explored a hybrid approach to making 3D objects with computer-based tools through multiple methods. This included the curation of a public exhibition and symposium. This 'curatorial practice-based' approach proved a successful research method.

Organising these events gave the researcher access to extensive primary sources that would have been unavailable otherwise. The researcher used the curation of the exhibition and symposium to examine contemporary practitioners, objects, constituents and audiences in a 'live' context. The process of securing public funding from Arts Council England and creating partnerships with various stakeholders built peer-review into the curatorial process. The curation of these events was also useful in defining the bounds of a specific set of practitioners and objects as case studies. This was effective in narrowing a field that would otherwise have been impossibly complex.

The multiple sources for data collection the exhibition and symposium created provided the researcher with opportunities to triangulate evidence and strengthen the research findings and conclusions. The curation of the exhibition brought together a group of practitioners and objects that would not have come into contact otherwise. The exhibition allowed practitioners, peers and audiences to question and examine the propositions and arguments developed in this thesis and reach understandings independent of the researcher. It also provided opportunities for the researcher to capture this qualitative data through interviews and surveys.

Direct contact and negotiation with practitioners and stakeholders through the curation of the exhibition challenged the researcher to move beyond first assumptions and improve the likelihood of accurate and reliable findings. A goal and characteristic of exemplary case studies is that they report data in a way that transforms a complex issue into one that can be understood. The 'Perimeters, Boundaries and Borders' exhibition presented the argument developed in this thesis in a publicly accessible form that invited alternative analyses.

There are disadvantages of using the curation of a public exhibition and symposium as a research method. This method can be criticised in that a study of a few cases offers no grounds to show reliability or generality for the findings. There must however be greater impartiality than more conventional forms of practice-based research since this study benefits by being able to make direct use of a body of work other than the researcher's own. Another potential criticism of this method is that the involvement of the researcher within the process biases these findings. This research is reflexive it actively contributes to the field of enquiry. The researcher commissioned new works from practitioners in response to a brief. Many of the practitioners that took part in the exhibition can be said to have self-selected themselves by responding to the open call and have received wider recognition for their work because of this exhibition. In this way the research has actively contributed to framing a new context for the exhibition participants and could be interpreted as demonstrating a self-fulfilling bias. In order to maintain objectivity the researcher has applied a systematic method of collecting data, analysing information, and reporting the results to offset his participatory role in the research. This meant that extensive record-keeping techniques were essential for this work. The process of maintaining and updating this evidence was time-consuming and at times overwhelming. This is a factor that should be taken into account in future when considering this type of study. Although the research described in this thesis has limits, it provides a substantial starting point from which to carry out future work. As a first stage of research in this area it has mapped out a territory, both theoretical and practicable, within which subsequent investigations can be conducted.

6.5 Outcomes

This research project has successfully positioned itself over or between disciplines and has developed its own methods to pursue this enterprise. It has resulted in insights, outcomes and contributions that are applicable across the 3D art and design disciplines. The achieved outcomes include:

- A survey of existing works from the field of enquiry. This resulted in descriptions of new methods of working with computer-based tools in art and design and the development of evaluative criteria and critical language for computer-designed and/or fabricated objects.
- An indicative model of the phases that art and design practitioners go through when they integrate computer-based tools into their practice was produced. This was derived from an existing technology adoption model.
- A form of 'technology-led-practice' was identified and defined.
- A curatorial framework for a public exhibition and symposium was developed. Qualitative data from practitioners, project stakeholders and audiences from these events revealed patterns and themes relevant to the theoretical framework of this study.
- An increased capacity for a 'transdisciplinary discourse' at the intersection of disciplinary domains was identified.
- A contemporary version of R. Krauss's 'Klein Group' diagram was developed as means of visualising the field of enquiry and the relationships between objects from the field and the 'hybrid' forms of art and design practice that produced them.
- Contributions were also made to the literature of the field of enquiry.

6.6 Concluding remarks and future research

There is an expectation that digital fabrication will eventually allow a mass audience to manufacture physical items at home directly from their computer desktop. New production paradigms have brought producers and consumers into a closer relationship. Computer-based design and fabrication can invert the conventional sequence of product development and manufacturing and bring about a more distributed model of digital production. All this points to the wider circulation of objects not defined by the existing values of established design discourses. Practitioners are making use of digital tools in cultural

contexts that can question notions of originality, uniqueness and authorship. These developments collectively reframe the relationship between objects, their makers and their audiences throughout a designed object's life cycle. Future work is necessary to better understand the nature of these audiences, users and consumers of the types of objects discussed in this thesis. Who are they? The practitioners surveyed said the primary means of consumption of their products were through exhibitions, education and as research papers and presentations. However, it is clear from the responses from practitioners that not much else is understood about this.

The Cox Review of Creativity in Business (Cox, 2005) was commissioned to examine how UK enterprises can better meet competition from emerging economies. The review looks at what can be done to encourage new ideas and exploit emerging technologies and changes in markets. This research project was conducted with an awareness of the new economic opportunities these political changes offer for hybrid art and design practitioners. The researcher views the Cox Review as both an opportunity for and a challenge to art and design practitioners able or willing to embrace the 'creative industries' label. Is hybrid practice an adaptation to the creative stresses and pressures of the 21st Century? Many of the practitioners contacted for this study are consciously exploring the possibility that digital production can create more sustainable forms of practice and new economic opportunities for themselves. This indicates an opportunity for more extensive analysis of the implications of this through future research.

There are many implications arising from this research for pedagogy. An unexplored issue that emerged from this study is that a distinct, domain-specific mind-set is more prevalent in the UK than in other nations. This poses an interesting subject for a future study. If this is true, why is it so? Universities are structured around disciplines. Do existing models of academia act as artificial barriers? If overcome, what might be the advantages for the next generation of art and design practitioners? Educators need to address the following questions. How do we teach students to develop a critical, technological awareness? What is a fitting body of knowledge for a computer-based or hybrid art and design course? What skills are essential? What theories

underpin computer-based or hybrid practice? The researcher hopes this research suggests places to begin to address these questions. Further collaborative work across art and design subject domains is necessary to produce a more universally applicable system of classification and examination in the expanded context of making objects with computer-based tools. The research presented in this study is offered to the field to be critiqued, adapted and built on.

7.0 Glossary

CAD/CAM is the combined acronyms of computer-aided design and computer-aided manufacturing. CAD is the use of a wide range of computer-based tools (both software and hardware) that can be used to define 2D and 3D geometry for use in many other applications. Computer-aided manufacturing (CAM) refers to the use of CAD software to generate the instructions for a Computer Numerical Control (CNC) machine tools (for example three and five axis milling machines, multiaxis laser and water-jet cutters, tube benders, roll formers lathes, etc.). These are subtractive fabrication methods in which some form of computer-driven tool cuts, bends, folds, welds, rolls, forms, punches, or moulds stock materials with much precision in two or more axes. CNC machining has been available since the 1950s yet it is recent that the economic and computational limitations (access to technology and ability to make use of it without highly specialised knowledge) have come within the budget and technical capabilities of small enterprises and individual practitioners.

Rapid prototyping and manufacturing (RP&M) consist of a number of methods developed since the mid 1980s to fabricate physical 3D objects directly from CAD data without the use of a mould. These methods are also known as 3D printing, additive fabrication, solid freeform fabrication and layer manufacturing. These are processes of micro lamination that essentially reduce a digital 3D object to a stack of 2D profiles used to build up an object one slice at a time from a few materials in powder, paste or liquid form. Rapid prototyping and manufacturing techniques that are commercially available include:

> Stereolithography (SLA®)[133] - is a rapid prototyping (RP) technology. This process uses a vat of liquid photopolymer epoxy resin and an ultraviolet laser to build parts one layer at a time. The laser traces a cross-section of the object on the surface of the liquid resin. Exposure to the beam solidifies the resin in the shape traced and bonds it to the layer below.

[133] http://www.3dsystems.com/products/sla/index.asp

Selective Laser Sintering (SLS®)[134] is an additive rapid prototyping (RP) technology. Nylon or metal powder is applied in fine layers and sintered in a series of 2D sections by a CO_2 laser into a solid mass defined from a 3D digital description of the part.

Laminated Object Manufacturing (LOM™)[135] is a fabrication process that uses a laser to cut successive cross-sections of an object from layers of paper applied from a roller with an adhesive coating on the backside. The laser cuts the outline of the cross-sections that form the object. Once the laser has cut the object it proceeds to create hatch marks that surround the object with squares that can be removed as cubes once the entire object has been laminated and cut. When all the cubes have been removed, the part is sanded down and a lacquer is used to seal it. The finished part has a surface and density similar to wood.

Fused Deposition Modeling (FDM™)[136] is a rapid prototyping (RP) technology. A plastic filament is heated to melt the material and can then be extruded through a numerically controlled nozzle.

3D printing[137] is a category of rapid prototyping (RP) technology. These are various methods of converting a digital 3D model into a physical object. The 3D printer spreads out a thin layer of material (for example gypsum powder or molten wax). Between layers the build piston drops down, making room for the next layer. This process is repeated and each successive layer is bonded to the next layer from the print head.

3D Scanning allows for the digital replication of real world objects. Utilising the latest motion control and handheld laser scanners virtual models can be created in 3D from a real world object or environment. A 3D scanner is a device that analyses a real-world object or environment to collect data on its shape. This usually creates a point cloud which is used to reconstruct the surface of the

[134] http://www.3dsystems.com/products/sls/index.asp
[135] http://www.cubictechnologies.com/Prototyping/INDEX.HTM
[136] http://intl.stratasys.com/index.html
[137] e.g. http://www.3dsystems.com/products/multijet/index.asp, http://www.2objet.com/, http://www.solid-scape.com/ and http://www.zcorp.com/home.asp

object scanned. The collected data can then be used to construct digital, three-dimensional models useful for a wide variety of applications.

Computer-generated imagery (CGI) is the application of 3D computer graphics as used in special effects, simulators, visualisation and printed media.

A global positioning system receiver (GPS) can determine its location, speed and direction by receiving information from an array of satellites.

A microcontroller is a chip that contains a processor ROM or flash memory, RAM memory, a clock and an input-output control unit. A microcontroller is designed for a specific task for example to control a particular system.

Motion Capture is a technique of digitally recording movements. Markers are placed on or near each of a performer's joints. The relative positions, angles, velocities, and accelerations are then recorded as animation data. In McLundie (2006) recent advances in haptic input technologies that afford more direct manipulation of models in 3D space are documented.

Radio frequency identification (RFID) is a data collection technology that uses electronic tags for storing data.

8.0 References

3D SYSTEMS, 2007. 3D modeling & desktop prototyping with V-Flash by 3D Systems. Available online at: http://www.modelin3d.com/#Vflashbanner [Accessed 30 August, 2007].

ABBATE, J., 2004. Joseph Kosuth's "Art after Philosophy". Available online at: http://www.student.unimelb.edu.au/~jabbate/On%20Art%20after%20Philosophy.htm#_ftnref1 [Accessed 23 November, 2004].

ACM SIGGRAPH, 1996. Charles Csuri. Available online at: http://www.siggraph.org/artdesign/profile/csuri/artworks/plot/plot16.html [Accessed 30 August, 2007].

AGRE, P., 1997. Computation and human experience, Cambridge: Cambridge University Press.

AISH, R., 2006. Exploring the analogy that parametric design is a game in OOSTERHUIS, K., and FEIREISS, L., eds. The architecture co-laboratory: game set and match II. On computer games, advanced geometries and digital technologies. Rotterdam: Episode Publishers. p.203.

ALEXANDER, A., 2006. Cyberpunk pioneer has designs on a better world. The Guardian. June 1. Available online at: http://technology.guardian.co.uk/weekly/story/0,,1786641,00.html [Accessed 30 August, 2007].

AMERICAN MACHINIST, 1998. The CAD/CAM hall of fame. Available online at: http://www.americanmachinist.com/304/Issue/Article/False/9168/Issue [Accessed 30 August, 2007].

APPLE, 2007. Apple leadership in K-12 education ACOT library. Available online at: http://www.apple.com/education/k12/leadership/acot/library.html [Accessed 30 August, 2007].

ARIAS, E.G., & FISCHER, G., 2000. Boundary objects: their role in articulating the task at hand and making information relevant to it. Available online at: http://l3d.cs.colorado.edu/~gerhard/papers/icsc2000.pdf [Accessed 30 August, 2007]

ARS ELECTRONICA LINZ GMBH, 2007a. Ars Electronica. Available online at: http://www.aec.at/en/index.asp [Accessed 30 August, 2007].

ARS ELECTRONICA LINZ GMBH, 2007b. Hybrid art. Available online at: http://www.aec.at/en/prix/cat_hybrid_art.asp#details [Accessed 30 August, 2007].

ARTS AND HUMANITIES RESEARCH COUNCIL, 2003. Arts and Humanities Research Council - research subject coverage. Available online at: http://www.ahrc.ac.uk/about/subject_coverage/research_subject_coverage.asp#respanel2 [Accessed 30 August, 2007].

ARTSWAY, 2000. At home with art. Available online at: http://www.artsway.org.uk/AT_HOME/pic_1.htm [Accessed 30 August, 2007].

ATKINSON, P. and DEAN, L., 2003. Teaching techné. 5th European Academy of Design Conference, Barcelona. Available online at: http://www.ub.es/5ead/PDF/10/Atkinson.pdf [Accessed 28 August, 2007].

ATKINSON, P., 2003. FutureFactories: design work by Lionel Theodore Dean. Huddersfield: University of Huddersfield Press.

ATTFIELD, J., 2000. Wild things: the material culture of everyday life. Oxford: Berg Publishers.

AZUMA, H., 2001. Superflat Japanese Postmodernity. Available online at: http://www.hirokiazuma.com/en/texts/superflat_en1.html [Accessed 30 August, 2007].

BADKE, C., & WALKER, S., 2005. Contextualizing consumption. In RODGERS, P., BRODHURST, L., & HEPBURN, D., Crossing design boundaries. Taylor & Francis: London. p.289-293.

BALL, R., & NAYLOR, M., 2005. Form follows idea. London: Black Dog Publishing.

BATES, A. 2007. News (Drummond Masterton). Icon Magazine. May, 2007 p.41.

BATES, A., & JAMES, L., 2006. Design is evil. Icon 041. November. P.104-114.

BAUDRILLARD, J., 1994. Simulacra and simulation. Ann Arbor: University of Michigan Press.

BAUDRILLARD, J., 1996. The system of objects. London: Verso.

BEAMAN, J., 1997. The early roots of rapid mechanical prototyping technology can be traced to at least two technical areas: topography and photosculpture. Available online at: http://www.wtec.org/loyola/rp/03_01.htm [Accessed 30 August, 2007].

BELL, D., 1973. The coming of post-industrial society. London: Heinemann.

BENJAMIN, W., 1992. Illuminations. London: Fontana.

BIG BLUE SAW, 2007. Big Blue Saw: online manufacturing and waterjet cutting. Available online at: http://www.bigbluesaw.com/saw/ [Accessed 30 August, 2007].

BJÖRNSSON, H., SHARIQ, S., & TAYLOR, J., 2003. Bridging the innovation gap in the AEC industry. Available online at: http://www.stanford.edu/~jetaylor/InnovationGap.htm [Accessed 30 August, 2007].

BLEECKER, J., 2006. A manifesto for networked objects — cohabiting with pigeons, arphids and Aibos in the internet of things. Available online at: http://www.nearfuturelaboratory.com/files/WhyThingsMatter.pdf [Accessed 30 August, 2007].

BLOEMINK, B., 2004. Design ≠ art: functional objects from Donald Judd to Rachel Whiteread. London: Merrell Publishers.

BOLTER, J. & GRUSIN, R., 1999. Remediation: understanding new media. Cambridge, Massachusetts: The MIT Press.

BOSTON CYBERARTS, INC., 2004. Boston Cyberarts Festival 1999. Available online at: http://bostoncyberarts.org/archives/fest1999/1999frameset.html [Accessed 30 August, 2007].

BOURRIAUD, N., 2002. Relational aesthetics. Dijon: Les Presses du Réel.

BOWKER, G. & STAR, S. L., 1999. Sorting things out: classification and its consequences. Cambridge, Massachusetts: The MIT Press.

BRISCOE, C., HOWARD, G., SEKERS, A. & VINER, D., 1988. Art & computers. Middlesbrough: Cleveland Gallery.

BROCKMAN, J.,1995. The third culture - beyond the scientific revolution. New York: Simon & Schuster.

BROWN, J.S., 1996. To dream the invisible dream. Communications of the ACM, August, Vol. 39, No 8. p.30.

BULLIVANT, L., 2006. Responsive environments: architecture, art and design. London: V&A Publications.

BULLIVANT, L., ed. 2005. 4dspace: interactive architecture. London: Wiley-Academy.

BUNNELL, K., 1998. The integration of new technology into ceramic designer-maker practice. [CD-ROM]. PhD thesis. Aberdeen: The Robert Gordon University.

BUNNELL, K., 2004. Craft and digital technology. Available online at: http://www.autonomatic.org.uk/downloads/craft%20and%20digital%20technology.pdf [Accessed 30 August, 2007].

BÜRGER, P., 1984. Theory of the avant-garde (translation by Michael Shaw). Minneapolis: University of Minnesota Press.

BURY, S., 2001. Artists' multiples 1935-2000. Aldershot: Ashgate.

CALLICOTT, N., 2001. Computer-aided manufacture in architecture the pursuit of novelty. Oxford: Architectural Press.

CALLINICOS, A., 1989. Against postmodernism: a Marxist critique. Cambridge: Polity Press.

CANDY, L., & EDMONDS, E., 2002. Interaction in art and technology. Crossings: eJournal of Art and Technology. Vol. 2, Issue 1, March. Available online at: http://crossings.tcd.ie/issues/2.1/Candy/ [Accessed 30 August, 2007].

CARDOSO, R., 2004. Putting the magic back into design: from object fetishism to product semantics and beyond. Available online at: http://www.waspress.co.uk/journals/artontheline/journal_20041/articles/pdf/20041_02.pdf [Accessed 10 November, 2004].

CARLSON, W., Undated. Computer artists. Available online at: http://accad.osu.edu/~waynec/history/lesson9.html [Accessed 30 August, 2007].

CENTER FOR ADVANCED VISUAL STUDIES, 2007. Massachusetts Institute of Technology Center for Advanced Visual Studies. Available online at: http://cavs.mit.edu/ [Accessed 30 August, 2007].

CENTURY, M., 1999. Pathways to innovation in digital culture. Montreal: McGill University.

CHAPMAN, J., 2005. Emotionally durable design: objects, experiences and empathy. London: Earthscan Publications Ltd.

COLES, A., 2005a. DesignArt. London: Tate Publishing.

COLES, A., 2005b. On art's romance with design. Design Issues 21[3] 17-24.

COLES, A., 2007. Design and art. Cambridge, Massachusetts: The MIT Press.

COLLINS, D., 2005. Telesculpture. Available online at: http://telesculpture.prism.asu.edu/ [Accessed 30 August, 2007].

COMPUTER ARTS SOCIETY, 2007. The Computer Arts Society (CAS). Available online at: http://en.wikipedia.org/wiki/Computer_Arts_Society [Accessed 30 August, 2007].

CONNECTIVITY, 2007. Connectivity project. Available online at: http://www.connectivityproject.com/ [Accessed 30 August, 2007].

COOPER-HEWITT, NATIONAL DESIGN MUSEUM, 2004. Design is not art. Available online at: http://www.cooperhewitt.org/EXHIBITIONS/dina/site/webpages/dina.html [Accessed 30 August, 2007].

COX, G., 2005. Cox review of creativity in business: building on the UK's strengths. Available online at: http://www.hm-treasury.gov.uk/independent_reviews/cox_review/coxreview_index.cfm [Accessed 30 December, 2005].

DAUERER, V., 2007. Interview with Digitalability curator Atilano González-Pérez. Available online at: http://pingmag.jp/2007/05/11/digitalability/ [Accessed 30 August, 2007].

DAVIS, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), p.319-339.

DAVIS, S., 1987. Future perfect. Boston: Addison Wesley Longman Publishing Co.

DEAN, L.T., ATKINSON, P., & UNVER, E., 2005. FutureFactories: inverting the mass-production paradigm. Available online at: http://www.falmouth.ac.uk/img/pdf/00000452.pdf [Accessed 9 June, 2005].

DELEUZE, G., 1992. The Fold: Leibniz and the Baroque. Minneapolis: University of Minnesota Press.

DESKTOP FACTORY, 2007. Desktop Factory: 3D printers. Available online at: http://www.desktopfactory.com/ [Accessed 30 August, 2007].

DEVEREUX, J., 2002. Mass customization: let consumers collaborate on product designs. Available online at: http://www.metropolismag.com/html/content_0802/cus/ [Accessed September 28, 2004].

DIANA, C., 2007. Device art: coming to America? Available online at: http://www.core77.com/reactor/07.07_deviceart.asp [Accessed 30 August, 2007].

DILLER, E., & SCOFIDIO, R., 2002. Blur: the making of nothing. New York: Harry N. Abrams, Inc.

DUCHAMP, M., 1961. The creative act. Lecture at the Museum of Modern Art, New York, October 19, 1961. Published in: Art and Artists, 1, 4 (July 1966).

DUNNE, A., & RABY, F., 2001. Design noir: the secret life of electronic objects. London: August/Birkhauser.

DUNNE, A., & RABY, F., 2007. Critical design F.A.Q. Available online at: http://www.z33.be/debat/files/dunnerabyfaq.pdf [Accessed 30 August, 2007].

DUNNE, A., 1999. Hertzian tales: electronic products, aesthetic experience and critical design. London: RCA Computer Related Design Research.

DWYER, D.C., RINGSTAFF, C., & SANDHOLTZ, J.H., 1990. Teacher beliefs and practices part 1: patterns of change the evolution of teachers' instructional beliefs and practices in high-access-to-technology classrooms first–fourth year findings. Available online at: http://images.apple.com/education/k12/leadership/acot/pdf/rpt08.pdf [Accessed 30 August, 2007].

ELFLINE, R.K., 2004. What's the use? Art Journal, Spring.

EMACHINESHOP, 2007. Emachineshop. Available online at: http://www.emachineshop.com/ [Accessed 30 August, 2007].

ENCYCLOPAEDIA BRITANNICA, 2007. Art. Available online at: http://www.britannica.com/ebc/article-9355856 [Accessed 30 August, 2007].

EVIL MAD SCIENTIST LABORATORIES, 2007. Evil Mad Scientist Laboratories – solid freeform fabrication: DIY, on the cheap, and made of pure sugar. Available online at: http://www.evilmadscientist.com/article.php/candyfab [Accessed 30 August, 2007].

EYEBEAM OPENLAB, 2007. The Eyebeam OpenLab. Available online at: http://research.eyebeam.org/ [Accessed 30 August, 2007].

FAB@HOME, 2007. Fab@Home home page. Available online at: http://www.fabathome.org/ [Accessed 30 August, 2007].

FABJECTORY, 2007. Fabjectory - virtual objects in real life. Available online at: http://www.fabjectory.com/ [Accessed 30 August, 2007].

FAIRS, M., 2004. What is design? Available online at: http://www.icon-magazine.co.uk/issues/018/whatisdesign.htm [Accessed 18 November, 2005].

FAIRS, M., 2006. Twenty-First Century design: new design icons, from mass market to avant-garde. London: Carlton Books.

FARIN, G., 2002. A history of curves and surfaces in CAGD. Available online at: http://www1.elsevier.com/homepage/sac/cagd/history.pdf [Accessed 30 August, 2007].

FLUSSER, V., 1999. The shape of things – a philosophy of design. London: Reaktion Books Ltd.

FOLDSCHOOL, 2007. Foldschool - cardboard furniture. Available online at: http://www.foldschool.com/ [Accessed 30 August, 2007].

FOLLETT, G., MOIR, S., & VALENTINE, L., eds. 2007. Future voices: celebrating diversity. Dundee: Duncan of Jordanstone College of Art & Design.

FOSTER, H., ed. 1985. Postmodern culture. London: Pluto Press.

FOUCAULT, M., 1970. The order of things: an archaeology of the human sciences. London: Routledge.

FOUCAULT, M., 1977. What Is an Author? in BOUCHARD, D.F., ed. Language, counter-memory, practice: selected essays and interviews. Ithaca: Cornell University Press.

FREEMAN, C., 1992. The economics of hope: essays on technical change, economic growth and the environment. London: Pinter.

FRIED, M., 1967. Art and objecthood in HARRISON, C., and WOOD, W., eds. 1993. Art in theory: 1900–1990. Cambridge, Massachusetts and London: Blackwells.

FRIEDMAN, K., 2000. Design knowledge: context, content and continuity in DURLING, D., ed. Doctoral education in design: foundations for the future. Stoke-on-Trent: Staffordshire University Press.

FURNEAUX, B., 2006. Technology acceptance model. Available online at: http://www.istheory.yorku.ca/Technologyacceptancemodel.htm [Accessed 30 August, 2007].

GABLIK, S., 1985. Has Modernism failed? London: Thames & Hudson Ltd.

GANIS, W. V., 2004. Digital Sculpture: Ars ex machina. Sculpture Magazine. September, Vol. 23, No. 7.

GEHRY TECHNOLOGIES, 2007. Gehry Technologies digital project for CATIA. Available online at: http://www.gehrytechnologies.com/products-dp-catia.html [Accessed 30 August, 2007].

GERO, J.S., 1990. Design prototypes: a knowledge representation scheme for design. AI Magazine. 11(4). p.26-36.

GERSHENFELD, N., 2005. Fab: the coming revolution on your desktop - from personal computers to personal fabrication. New York: Basic Books.

GIBART, T., 2004. Objecthood. Available online at: http://csmt.uchicago.edu/glossary2004/objecthood.htm [Accessed 30 August, 2007].

GIBBONS, M., LIMOGES, C., NOWOTNY, H., SCHWARTZMAN, S., SCOTT, P. & TROW. M., 1994. The new production of knowledge. The dynamics of science and research in contemporary societies. London: Sage Publications Ltd.

GIBSON, W., 1999. All Tomorrow's Parties. New York: Ace Books.

GLASER, B.G., & STRAUSS, A., 1967. The discovery of grounded theory: strategies for qualitative research. Chicago: Aldine.

GORMAN, C., 2003. The industrial design reader. New York: Allworth Press.

GRAHAM, B., 1997. A study of audience relationships with interactive computer-based visual artworks in gallery settings, through observation, art practice, and curation. PhD thesis. University of Sunderland.

GRAHAM, B., 2005. Taxonomies of new media art - real world namings. Available online at: http://www.archimuse.com/mw2005/papers/graham/graham.html [Accessed 30 August, 2007].

GRAHAM, B., 2007. Redefining digital art: disrupting borders in CAMERON, F., and KENDERLINE, S., eds. Theorizing digital cultural heritage: a critical discourse. Cambridge, Massachusetts: The MIT Press.

GREENBERG, C., 1965. Modernist painting in HARRISON, C., and WOOD, W., eds. 1993. Art in theory: 1900–1990. Cambridge, Massachusetts and London: Blackwells.

GROPIUS, W., 1923. The theory and organization of the Bauhaus in HARRISON, C., and WOOD, W., eds. 1993. Art in theory: 1900–1990. Cambridge, Massachusetts and London: Blackwells.

GWILT, I., & BUNKLEY, B., 2005. Made Known: rapid prototype sculpture. Available online at: http://www.utsgallery.uts.edu.au/gallery/past/2005/made_0905.html [Accessed 30 August, 2007].

GWILT, I., ed. 2006. MadeKnown: digital technologies and the ontology of making. Sydney: University of Technology, Sydney, Faculty of Design, Architecture and Building.

HARROD, T., 2002. Otherwise unobtainable: the applied arts and the politics and poetics of digital technology. Available online at: http://www.pixelraiders.org/ [Accessed 25 May, 2006].

HEIDEGGER, M., 1976. Poetry, language, thought. New York: Harper Perennial.

HEIDEGGER, M., 1977. The question concerning technology and other essays. New York: Harper Torchbooks.

HEIDENREICH, S., 2007. Digitalability | on digitalability. Available online at: http://www.designmai.de/cgi-bin/designmai2007.pl/Digitalability/Essay?lang=en [Accessed 30 August, 2007].

HENSEL, M., MENGES, A., & WEINSTOCK, M., eds. 2004. Emergence: morphogenetic design strategies. London: Wiley-Academy.

HENSEL, M., MENGES, A., & WEINSTOCK, M., eds. 2006. Techniques and technologies in morphogenetic design. London: Wiley-Academy.

HEPPELL, S., 2006. RSA Lectures: learning 2016. Available online at: http://www.teachers.tv/video/4957 [Accessed 30 August, 2007].

HODGSON, E., 1998. The CALM (creating art with layer manufacture) project. Available online at: http://www.webarchive.org.uk/pan/10778/20050803/www.uclan.ac.uk/clt/calm/overview.htm [Accessed 30 August, 2007].

HOFFMAN, D., 1994. Architecture Studio: Cranbrook Academy of Art, 1986-93. New York: Rizzoli.

HOHL, M., 2006. This is not here: connectedness, remote experiences and immersive telematic art. PhD thesis. Sheffield Hallam University.

HOPKINSON, N., HAGUE, R.J.M., & DICKENS, P.M., eds. 2005. Rapid manufacturing: an industrial revolution for a digital age. Chichester: John Wiley and Sons Ltd.

INSTRUCTABLES, 2007. Instructables - how to make cool DIY projects. Available online at: http://www.instructables.com/ [Accessed 30 August, 2007].

JACKSON, L., 2004. Craft wars. Available online at: http://www.icon-magazine.co.uk/issues/016/essay.htm [Accessed 30 August, 2007].

JACKSON, L., 2007. News (Tavs Jørgensen). Icon Magazine. April. Available online at: http://www.icon-magazine.co.uk/issues/046/tavs.htm [Accessed 30 August, 2007].

JACOBS, P. F., 1995. Stereolithography and other RP&M technologies: from rapid prototyping to rapid tooling. New York: Society of Manufacturing Engineers.

JAMESON, F. 1981. The political unconscious: narrative as a socially symbolic act. Ithaca, New York: Cornell University Press.

JAMESON, F., 1991. Postmodernism or, the cultural logic of late capitalism. London: Verso.

JANZ, B., 1998. Transdisciplinarity as a model of post/disciplinarity. Available online at: http://pegasus.cc.ucf.edu/~janzb/papers/transdisciplinarity.pdf [Accessed 30 August, 2007].

JENCKS, C., 1987. The emergent rules. Reprinted in DOCHERTY, T., ed. 1993. Postmodernism: a reader. New York: Columbia University Press. p.281-294.

JENKINS, I., 2003. Art for art's sake. The Dictionary of the History of Ideas. Available online at: http://etext.virginia.edu/cgi-local/DHI/dhi.cgi?id=dv1-18 [Accessed 30 August, 2007].

JICK, T.D., 1979. Mixing qualitative and quantitative methods: triangulation in action. Administrative Science Quarterly, 24, p.602-611.

JOHANSSON, T.D., 2006. Art in the context of design, design in the context of art. Working Papers in Art and Design 4. Available online at: http://www.herts.ac.uk/artdes1/research/papers/wpades/vol4/tdjabs.html [Accessed 11 January, 2007].

KANG, J., & CUFF, D., 2005. Pervasive computing: embedding the public sphere. Washington and Lee Law Review, Vol. 62.

KERNE, A., 2006. Doing interface ecology: the practice of metadisciplinarity. Intelligent agent. Vol. 6, No. 1. Available online at: http://www.intelligentagent.com/archive/Vol6_No1_interface_kerne.htm [Accessed 30 August, 2007].

KIM, S.N., & GAFFIKIN, M., 2005. Accounting for negativity: from a Buddhist perspective. Available online at: http://www.mngt.waikato.ac.nz/ejrot/cmsconference/2005/proceedings/criticalaccounting/Kim.pdf [Accessed 30 August, 2007].

KLEIN, J. T., 1990. Interdisciplinarity: history, theory and practice. Detroit: Wayne State University.

KLEIN, J. T., 1994. Notes toward a social epistemology of transdisciplinarity. Available online at: http://nicol.club.fr/ciret/bulletin/b12/b12c2.htm [Accessed 30 August, 2007].

KLÜVER, B., 2000. Billy Klüver: Experiments in Art and Technology (E.A.T.). Available online at: http://www.fondation-langlois.org/html/e/page.php?NumPage=306 [Accessed 30 August, 2007].

KOBA INDUSTRIES, 2007. Koba Industries. Available online at: http://www.kobask8.com/servlet/StoreFront [Accessed 30 August, 2007].

KOLAREVIC, B., 2005. Architecture in the digital age: design and manufacturing. London: Taylor & Francis Ltd

KRAUSS, R., 1979. Sculpture in the expanded field. Reprinted in FOSTER, H., ed. 1983. The anti-aesthetic. Seattle: Bay Press.

KRIPPENDORFF, K., 1995. Redesigning design an invitation to a responsible future in TAHKOKALLIO, P., & VIHMA, S., eds. Design - pleasure or responsibility? Helsinki: University of Art and Design.

KUSAHARA, M., 2006. Device art: a new form of media art from a Japanese perspective. Available online at: http://intelligentagent.com/archive/ia6_2_pacificrim_kusahara_device art.pdf [Accessed 30 August, 2007].

KWON, M., 2002. Jorge Pardo's designs on design. In COLES, A., 2007. Design and art. Cambridge, Massachusetts: The MIT Press.

LA FONDATION DANIEL LANGLOIS, 2004. Software, Information Technology: its new meaning for art. Available online at: http://www.fondation-langlois.org/html/e/page.php?NumPage=541 [Accessed 30 August, 2007].

LA FONDATION DANIEL LANGLOIS, 2005. Maurice Tuchman, a report on the art and technology program of the Los Angeles County Museum of Art. Available online at: http://www.fondation-langlois.org/html/e/page.php?NumPage=706 [Accessed 30 August, 2007].

LAVIGNE, C., 2007. Intersculpt. Available online at: http://www.pimkey.com/~interscu/ [Accessed 30 August, 2007].

LAWSON, B., 2004. What designers know. Oxford: Architectural Press.

LEACH, N., TURNBULL, D., & WILLIAMS, C., eds. 2004. Digital tectonics. London: Wiley-Academy.

LEMKE, J.L., Undated. Theory of complex self-organizing systems. Available online at: http://academic.brooklyn.cuny.edu/education/jlemke/theories.htm [Accessed 30 August, 2007].

LIMING, R., 1944. Practical analytical geometry with applications to aircraft. New York: Macmillan.

LISTER, M., DOVEY, J., GIDDINGS, S., GRANT, I., & KELLY, K., eds. 2003. New media: a critical introduction. London: Routledge.

LOPICCOLO, P., 2002. 25 Year retrospective (part 2) CAD/CAM/CAE. Computer Graphics World. Volume: 25 Issue: 2, February.

LUPTON, E., 1998. Design and production in the mechanical age in Rothschild, D., LUPTON, E., & GOLDSTEIN, D. Graphic design in the mechanical age: selections from the Merrill C. Berman Collection. New Haven and London: Yale University Press.

LYNN, G., & RASHID, H., 2003. Architectural laboratories. Rotterdam: Netherlands Architecture Institute.

LYNN, G., 1998. Folds, bodies and blobs: collected essays. Brussels: La Lettre Volée.

LYOTARD, J.F., 1984. The Postmodern condition: a report on knowledge. Manchester: Manchester University Press.

MACDONALD, N., 2005. Better by design. RSA Journal, August. Available online at: http://www.rsa.org.uk/journal/article.asp?articleID=575# [Accessed 30 August, 2007].

MACGREGOR, B., 2002. Cybernetic Serendipity revisited. Proceedings of the Fourth Conference on Creativity & Cognition. New York: ACM Press.

MALINS, J., PENGELLY, J., & MARSHALL, J., 2007. The post disciplinary digital practitioner. In BOHEMIA, E., HILTON, K., MCMAHON, C., & CLARKE, A., eds. Shaping the future? Basildon: Hadleys Ltd. p.437-441.

MAKE, 2007. Make. Available online at: http://www.makezine.com/blog/ [Accessed 30 August, 2007].

MANOVICH, L., 1996. On totalitarian interactivity (notes from the enemy of the people). Available online at: http://www.manovich.net/text/totalitarian.html [Accessed 30 August, 2007].

MANSILLA, V.B., & GARDNER, H., 2003. Assessing interdisciplinary work at the frontier. An empirical exploration of 'symptoms of quality'. Available online at: http://www.interdisciplines.org/interdisciplinarity/papers/6 [Accessed 30 August, 2007].

MARSHALL, J., and PENGELLY, J., 2005a. Perimeters, boundaries and borders: hybrid objects in the convergent fields of sculpture, industrial design and architecture. In PAN, Y., VERGEEST, J., LIN, Z., WANG, C., SUN, S., HU, Z., TANG, Y. & ZHOU, L., eds. Applications of digital techniques in industrial design engineering. Beijing: International Academic Publishers/World Publishing Corporation. p.308-313.

MARSHALL, J., and PENGELLY, J., 2005b. Perimeters, boundaries and borders: new dimensions of design in the convergent fields of sculpture, industrial design and architecture. In RODGERS, P., BRODHURST, L., & HEPBURN, D., Crossing design boundaries. Taylor & Francis: London. p.21-26.

MARSHALL, J., and PENGELLY, J., 2006. Computer technologies and transdisciplinary discourse: critical drivers for hybrid design practice? CoDesign, Vol. 2, No. 2. Taylor and Francis Ltd. p.109-122.

MARSHALL, J., ed. 2008. Perimeters, boundaries and borders. Fast-uk: Manchester. Available online at: http://www.lulu.com/content/2498538 [Accessed 8 July, 2008].

MARTIN, H., & GAVER, W., 2000. Beyond the snapshot from speculation to prototypes in audiophotography. Available online at: http://www.goldsmiths.ac.uk/interaction/pdfs/25martin-gaver.aphoto.dis00.pdf [Accessed 30 August, 2007].

MASTERTON, D., 2004. The hunt for complexity. Available online at: http://www.autonomatic.org.uk/downloads/The%20hunt%20for%20complexity.pdf [Accessed 9 June, 2005].

MCCULLOUGH, M., 1996. Abstracting craft: the practiced digital hand. Cambridge, Massachusetts: The MIT Press.

MCCULLOUGH, M., 2004. Digital Ground. Cambridge, Massachusetts: The MIT Press.

MCDONALD, J.A., RYALL, C.J., & WIMPENNY, D.I., eds. 2001. Rapid prototyping casebook. London: Professional Engineering.

MCLUNDIE, M., 2006. Beyond the formal/concrete axis: a study of individual difference in approach to design practice. PhD Thesis. Glasgow School of Art.

MICHEL, N. J., 2006. The impact of digital file sharing on the music industry: an empirical analysis. Topics in Economic Analysis & Policy. Volume 6, Issue 1, Article 18.

MICHL, J., 2004. Form follows what? The modernist notion of function as a carte blanche. Available online at: http://www.geocities.com/Athens/2360/jm-eng.fff-hai.html [Accessed 30 August, 2007].

MILLER, D., ed. 1998. Material cultures: why some things matter. London: UCL Press.

MORENO, S., 2005. Protect us from what Tobi wants. Frame. No. 42, Jan/Feb.

NEWMAN, M., 1994. Operation atopia in COOKE, L., HERZOGENRATH, W., LOOCK, U., NEWMAN, M., and ROBERTS, J., 1994. Julian Opie. London: Thames and Hudson Ltd.

NEXTENGINE, 2007. NextEngine desktop 3D scanner. Available online at: https://www.nextengine.com/ [Accessed 30 August, 2007].

NICOLESCU, B., 1993. Towards a transdisciplinary education. Paper presented at Education of the Future. Sao Paulo, Brazil. 4-8 October.

NORMAN, D. A., 2004. Emotional design: why we love (or hate) everyday things. New York: Basic Books.

OBJECTS OF VIRTUAL DESIRE, 2005. Objects of Virtual Desire. Available online at: http://www.objectsofvirtualdesire.com/ [Accessed 30 August, 2007].

OGLE, 2007. OGLE: OpenGLExtractor by Eyebeam R&D. Available online at: http://ogle.eyebeamresearch.org/ [Accessed 30 August, 2007].

P2P FOUNDATION, 2007. Desktop manufacturing. Available online at: http://www.p2pfoundation.net/Desktop_Manufacturing [Accessed 30 August, 2007].

PASQUARELLI, S. H., ed. 2002. Versioning: evolutionary techniques in architecture. London: Wiley-Academy.

PAUL, C., 1999. Fluid borders: the aesthetic evolution of digital sculpture. Available online at: http://www.sculpture.org/documents/webspec/digscul/digscul.shtml [Accessed 9 June, 2005].

PAUL, C., 2003. Digital art. London: Thames and Hudson Ltd.

PENNY, S., 1996. From A to D and back again: the emerging aesthetics of interactive art. Leonardo Electronic Almanac Volume 4, No. 4, April. Available online at: http://ace.uci.edu/penny/texts/atod.html [Accessed 30 August, 2007].

PEREIRA, R.E., 2002. An adopter-centred approach to understanding adoption of innovations. European Journal of Innovation Management. Volume 5, Issue 1. p.40-49.

PERRY, C., & HIGHT, C., 2006. Collective intelligence in design: new forms of distributed practice and design. London: Wiley-Academy.

PILLERS, M., 1998. MCAD Renaissance of the 90's a report on the state of the art. Available online at: http://www.edeinc.com/Cadence/98Mar/Article98Mar.html [Accessed 30 August, 2007].

PINE, B. J., 1993. Mass Customisation: The New Frontier in Business Competition. Boston: Harvard Business School Press.

POLLACK, B., 2001. Back to the future with BitStreams. Art in America. September. Available online at: http://findarticles.com/p/articles/mi_m1248/is_9_89/ai_78334695 [Accessed 30 August, 2007].

PONOKO, 2007. Ponoko - make it real. Available online at: http://ponoko.com/ [Accessed 30 August, 2007].

PONTUS HULTÉN, K.G., 1968. The machine (as seen at the end of the mechanical age), New York: The Museum of Modern Art.

POWELL, G., 2005. Inside the box (exhibition guide). Leamington Spa: Art Gallery and Museum Royal Pump Rooms.

POYNOR, R., 2005. Art's little brother. Available online at: http://www.icon-magazine.co.uk/issues/023/essay.htm [Accessed 30 August, 2007].

RAHIM, A., 2005. Catalytic formations. London: Taylor & Francis Ltd.

RAHIM, A., ed. 2002. Contemporary techniques in architecture. London: Wiley-Academy.

RAMMERT, W., 1999. Relations that constitute technology and media that make a difference: toward a social pragmatic theory of technicization. Available online at: http://scholar.lib.vt.edu/ejournals/SPT/v4_n3html/RAMMERT.html [Accessed 18 November, 2005].

RASHID, H., & COUTURE, L. A., 2002. Asymptote: flux. London: Phaidon Press Ltd.

RECURSIVE INSTRUMENTS, 2006. Recursive Instruments. Available online at: http://recursiveinstruments.com/ [Accessed 18 May, 2006].

REICHARDT, J., 2005. Cybernetic Serendipity. Available online at: http://www.medienkunstnetz.de/exhibitions/serendipity/ [Accessed 30 August, 2007].

RENDELL, J. 2006. Art and Architecture: a place between. London: I.B. Taurus & Co. Ltd.

REPRAP, 2007. RepRap. Available online at: http://reprap.org/bin/view/Main/RepRap [Accessed 30 August, 2007].

RHOADES, L.J., 2005. The transformation of manufacturing in the 21st Century. The Bridge. Volume 35, No. 1. Spring.

ROGERS, E. M., 2003. Diffusion of innovations, fifth edition. New York: Free Press.

ROLAND ASD, 2007. Roland ASD milling machines. Available online at: http://www.rolanddga.com/asd/products/milling/ [Accessed 30 August, 2007].

RUSSEL, W., 2000. Forging new paths: transdisciplinarity in universities. WISENET Journal, Number 53, April. Available online at: http://www.wisenet-australia.org/issue53/transdis.htm [Accessed 30 August, 2007].

SAN FRANCISCO MUSEUM OF MODERN ART, 2001. 010101: art in technological times. Available online at: http://010101.sfmoma.org/ [Accessed 30 August, 2007].

SAN JOSE MUSEUM OF ART, 2005. Blobjects and Beyond: the new fluidity in design. Available online at: http://www.sjmusart.org/content/exhibitions/past/exhibition_info.phtml?itemID=211 [Accessed 30 August, 2007].

SANDHOLTZ, J.H., RINGSTAFF, C., & DWYER, D.C., 1990. Teaching in high-tech environments: classroom management revisited first–fourth year findings. Available online at:http://images.apple.com/education/k12/leadership/acot/pdf/rpt10.pdf [Accessed 30 August, 2007].

SCANLON, J., 2004. Frank Gehry for the rest of us. Available online at: http://www.wired.com/wired/archive/12.11/gehry.html [Accessed March 9, 2005].

SECOND LIFE, 2007. Second Life: Your world. Your imagination. Available online at: http://secondlife.com/ [Accessed 30 August, 2007].

SENGERS, P., BOEHNER, K., DAVID, S., & KAYE, J., 2005. Reflective design. Available online at: http://shaydavid.info/papers/sengersetalreflectivedesign.pdf [Accessed 6 December, 2005].

SENSEABLE TECHNOLOGIES, 2007. SenseAble Technologies. Available online at: http://www.sensable.com/ [Accessed 30 August, 2007].

SEVALDSON, B., 2005. Developing digital design techniques: investigations on creative design computing. PhD thesis. Oslo School of Architecture and Design, Oslo Norway.

SILVER, M., (Ed.) 2006. Programming cultures: architecture, art and science in the age of software development. London: Wiley-Academy.

SNOW, C.P., 1959. The two cultures and the scientific revolution, Cambridge: Cambridge University Press.

SOLÀ-MORALES RUBIÓ, I. de., 1995. Terrain vague in DAVIDSON, C. E., ed. Anyplace. Cambridge, Massachusetts: The MIT Press.

SPILLER, N., ed. 2002. Reflexive architecture. London: Wiley-Academy.

SPUYBROEK, L., 2004. NOX: machining architecture. London: Thames & Hudson Ltd.

STATHIS, P., 2000. Metaconsumption: is durability overrated? Available online at: www.highgrounddesign.com [Accessed 10 November, 2004].

STERLING, B., 2000. Blobjects and biodesign. Artbyte Magazine. March-April Issue. P.42-53 and p.90-91.

STERLING, B., 2004a. The dream factory any product, any shape, any size – manufactured on your desktop! Wired Issue 12.12, December.

STERLING, B., 2004b. When blobjects rule the earth. Available online at: http://www.boingboing.net/images/blobjects.htm [Accessed 30 August, 2007].

STERLING, B., 2005. Shaping things. Cambridge, Massachusetts: The MIT Press.

STOCKER, G., & SCHÖPF, C., 2005. Hybrid - living in paradox. Available online at: http://www.aec.at/en/archiv_files/20051/FE_2005_Hybrid_en.pdf [Accessed 30 August, 2007].

STORKERSON, P., 1997. Defining design: a new perspective to help specify the field. Available online at: http://www.communicationcognition.com/Publications/ConstructivistDesign.pdf [Accessed 18 November, 2005].

TECHSHOP, 2007. TechShop is the SF Bay area's only open-access public workshop. Available online at: http://www.techshop.ws/index.html [Accessed 30 August, 2007].

THACKARA, J., 1998. Design after Modernism: beyond the object. London: Thames and Hudson.

THACKARA, J., 2005. In the bubble: designing in a complex world. Cambridge, Massachusetts: The MIT Press.

THOMPSON, H. 2004. Play with fire. Blueprint. Issue 223, September. p78-82.

TIME-LIFE BOOKS, 1986. Toward a machine with interactive skills. Available online at: http://accad.osu.edu/~waynec/history/PDFs/Interactive-Sketchpad.pdf [Accessed 30 August, 2007].

TOFFLER, A., 1970. Future Shock, New York: Bantam Books.

TOMES, A., & ARMSTRONG, P., 2003. Dialectics of design: how ideas of 'good design' change. Available online at: http://www.ub.es/5ead/PDF/6/TomesArmstrong.pdf [Accessed 30 August, 2007].

TSENG, M.M., & JIAO, J., 2001. Mass customization. In Handbook of Industrial Engineering, Technology and Operation Management. 3rd. ed. p. 685.

UNTO THIS LAST, 2007. Unto This Last. Available online at: http://www.untothislast.co.uk/ [Accessed 30 August, 2007].

V2_, 2007. V2_ : Institute for the Unstable Media. Available online at: http://www.v2.nl/ [Accessed 30 August, 2007].

VERSALASER, 2005. Laser Systems product line. Available online at: http://www.ulsinc.com/versalaser/english/index.html [Accessed 30 August, 2007].

VIHMA, S., 2002. Design semantics and aesthetics in WOLFGANG, J., ed. The Basic Paradox. Available online at: http://home.snafu.de/jonasw/PARADOXVihmaE.html [Accessed 17 November, 2005].

VISSER, M., 2006. International Rapid Prototyping Sculpture Exhibition. Available online at: http://www.rpsculpture.org/ [Accessed 30 August, 2007].

VON HIPPEL, E., 2005. Democratizing innovation. Cambridge: The MIT Press.

WATERS, J. K., 2003. Blobitecture: waveform and organic design. Gloucester, MA: Rockport Publishers Inc.

WEISER, M., 1991. The computer for the Twenty-First Century. Scientific American. September, Vol 265, No 3, p.94-104.

WEXNER CENTER FOR THE ARTS, 2002. Moodriver. Available online at: http://www.wexarts.org/ex/2002/moodriver/ [Accessed 30 August, 2007].

WHITE, H., 2004. Hybrid practice - challenging traditional craft boundaries: authenticity: anxiety: autonomy. Available online at: http://www2.rgu.ac.uk/challengingcraft/ChallengingCraft/pdfs/hazelwhite.pdf [Accessed 30 August, 2007].

WHITNEY MUSEUM OF AMERICAN ART, 2001. BitStreams. Available online at: http://www.whitney.org/bitstreams/ [Accessed 30 August, 2007].

WILTSHIRE, A., 2005. Dunne and Raby. Icon 022. April. p.72-78.

WITCOMBE, C., 2000. Art for art's sake. Available online at: http://witcombe.sbc.edu/modernism/artsake.html [Accessed 24 March, 2006].

WRIGHT, S., 2000. The use-value of contemporary art. Available online at: http://www.apexart.org/residency/wright.htm [Accessed 30 August, 2007].

WRIGHT, S., 2005. The Future of the Reciprocal Readymade. Available online at: http://www.turbulence.org/blog/archives/000906.html [Accessed 17 November, 2005].

YIN, R., 2003. Case study research: design and methods. Thousand Oaks: Sage Publishing.

ZELLNER, P., 2000. Hybrid space: new forms in digital architecture. London: Thames & Hudson Ltd.

ZENTRUM FÜR KUNST UND MEDIENTECHNOLOGIE, 2007. ZKM | Center for Art and Media. Available online at: http://on1.zkm.de/zkm/e/ [Accessed 30 August, 2007].

9.0 Appendix I: Transcript of symposium

9.1 Paul Rodgers

Dr Paul A. Rodgers is Reader in the School of Design and Media Arts of Napier University, Edinburgh. Before this, he was employed at the University of Cambridge's Engineering Design Centre as a post doctoral Research Fellow. Dr Rodgers is the author of Inspiring Designers (published by Black Dog Publishers, London in December 2004) a major new book on the "iconic influences" of successful designers throughout the world, and editor in chief of Crossing Design Boundaries (published by Taylor and Francis, London in September 2005). Dr Rodgers has published more than 90 book chapters, International journal and conference papers. He is also a member of the Editorial Board of the International journal Design Studies.

Paul Rodgers
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I guess the first thing to say is to thank folly and John for inviting me here. It was a bit of a surprise. I currently work in the Design Department at Napier University and we've recently restructured ourselves and now have the glorious title of the School of Creative Industries – whatever that might be. At the moment my post has 3 main responsibilities: first and foremost is to teach as a Design tutor and I have responsibility to undergraduates and postgraduates and also PhD students. I am also an active researcher and I am on the editorial board for Design Studies which maybe positions me quite well. One of my colleagues describes me as a 'recovering reductionist' - which I do think is a bit harsh - but I do take a more empirical approach to design research. Lastly I'm a design practitioner. We have formed a design collective in Edinburgh made up

of a range of people: architects, furniture designers, multimedia designers, exhibition designers and over the last couple of years we've exhibited at Designers Block – part of London Design Festival. We have exhibited at The Lighthouse and plan to take it to Milan this year. So, there are a few things that I'm currently involved in.

To provide you with a little bit more context at present I'm Programme Director of a course called Interdisciplinary Design. It is a Masters course and we also have an undergraduate course which filters into this which is titled Design Futures. It is fairly unique in the sense that they take a social and cultural approach to design and less of an emphasis on commercial and technological aspects. So it has been relatively successful. Also, in the last couple of years I've published a couple of books and really that have focused on the diverse and wide ranging nature of contemporary design practice. The first was this one called 'Crossing Design Boundaries' which was published by Taylor and Francis and this was the result of a conference which the aim of was to get a wide range of people who were involved in many fields related to design. So there is a lot of contributions in the book from anthropologists; from psychologists; and people involved in the 'soft' aspects of computing (HCI), but also people that are perhaps under-represented in conferences and books of this nature – people that are jewellery designers or that design wearable products. Really we were trying to show how best those skills, knowledge and techniques could be exploited within a design context. The second book which is more recent than the first is 'Inspiring Designers' which is published by Black Dog in London and that is based on eighteen interviews that I conducted with what I think you could accurately describe as incredibly successful designers. In total I actually interviewed thirty designers across the world in Tokyo, Paris, the Netherlands, London and New York - it is important that I actually conducted each interview in the designers' own studio. The interviews were an attempt to reveal what drives them as designers and ask them to question why they think they've been successful; how they have got to be where they are; where they want to go; and what are the major influences that affect their work.

I thought I'd show you a number of recent past projects from our design students. I think these four or five slides illustrate well the emerging nature of

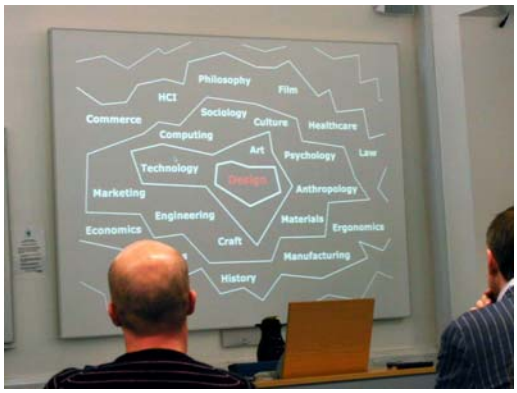
interdisciplinary design practice. This girl's project included a range of clothing and accessories for Seasonally Affected Disorder (SAD) sufferers which is fairly prevalent in Northern Europe – it is certainly prevalent in Glasgow where we don't see the sun on too many days. At present the range of products for SAD sufferers are incredibly clumsy. There is a sort of light box that you are meant to prop up on the table and eat your cornflakes at that is like a portfolio put on its end and beams a fairly substantial bright light at you. The other one is a skip cap that you are meant to wear all day long. But with the current threat of being given an ASBO (Anti Social Behaviour Order) or being described as a 'Chav' these are pretty clumsy, pretty god-damned awful to be honest. What Cookie proposed was a number of high fashion products including urban street wear – so the 'Hoodie' (which is actually in more danger of attracting an ASBO), a range of bags and a range of umbrellas. What is interesting about Cookie is that she worked with a wide range of people on the project and in many ways had to adopt the personas of these people. These included fashion buyers, pattern cutters, technologists and manufacturers. I think this project transcended many historical or conventional design boundaries including product, fashion, graphics but also has moved into fields such as electronics, marketing, dressmaking and branding. And as we speak I think there are possibilities of this proceeding further. She has interest from a couple of notable garment manufacturers in Milan.

The second project is all about good deeds. There is a book (the title of which eludes me at the moment) so there is a little bit of precedent before Joanne took this on. The concept really is to promote well-being and harmony amongst communities. It is largely Internet-driven and the good deeds service encompasses voluntary action such as cleaning your bosses' car – so that is her actually giving my car a wash – giving a stranger flowers or taking your neighbours' dog for a walk. Again, the project breaks a number of historic boundaries and disciplines including graphics, multimedia, branding but also the notion of entrepreneurship. What resulted from that was actually a published book which was incredibly successful.

The next project's origins lay in concerns with the authenticity of food. Again, the outcome was a booklet titled *Authenticity*. It was not just about the

authenticity of food but about authenticity in general. Leah was quite an interesting girl you would speak to her after the weekend and she'd tell you where she had been - places like 'Ollo Rosso' or 'The Witchery' in Edinburgh – places where people like me can't afford to go. She'd tell you which restaurants she'd been to but her desire was to show where food was coming from and how it is authenticated. The idea here was this interactive table that would let diners know what is available that night, where it has been farmed, the reputation and provenance of the farmer and also the cost of the dish. Again, you can see fairly obviously that this project transcends many boundaries for a product design student to undertake.

Lastly, this is an award-winning Royal Society of Arts project which transcends several conventional disciplines. The concept was developed in response to the RSA brief which was all about water on the go and asking people to consume more water. The proposal here was advocating a dual branding approach which is fairly common in commercial product design activities. So you have things like Sony Ericsson and Levi's – dual brands. The idea that Nick came up with was that the banks would actually collaborate with water companies. The idea is that just as you would go and top up your wallet with money that you would actually fill up your little bag or receptacle with water at the same time. They would be branded across both. This thing would fold up to the size of a credit card. So again, a fairly successful project.



Design transcends many historic subject areas

I think what I've attempted to show in these examples is that design now (perhaps necessarily) transcends many historic subject areas. This isn't new - I don't think this is a grand revelation - because I think design has always been

viewed as a bridge between technology and art. However, I think what is new is that in the publication of several books designers and design companies in general are now faced with adopting and utilising techniques and approaches that really until recently have been comparatively uncommon to them. One example is the use of anthropological techniques. There is a big word which is quite 'buzzy' at the moment in design circles and that is 'ethnography' and that is used increasingly badly by designers throughout the world. But I think if you look at the investment that designers and design companies make in anthropology and ethnography it is fairly significant. One company in particular involved in this is Ideo [www.ideo.com] and also Sonic Rim [www.sonicrim.com]. A lot of this is coming out of the USA at the moment.

Threefold changes

So we can say that designers are now asked to transcend many of these separate disciplines. What I've tried to do is categorise or distinguish the change that design faces at the moment. In my view these changes are threefold: professional – there is really a blurring of traditional design disciplines. I think the changes are also linked to economics, funding and employment patterns and also obviously the easiest one is technological developments in computing and manufacturing power.

If you look at a couple of weeks ago in *Design Week*, Richard Seymour (who is a partner in Seymour Powell a fairly well-known design consultancy in London) is on record in a fairly lengthy article stating that design is mutating. He actually claims that design is on the verge of splitting into to two separate disciplines. He states that what is needed in a modern, dynamic and highly competitive world is a different breed of designer. He suggests there are two types of

designer. One he terms the specialist executor and the second is the polymath interpolator and he says that sometimes you come across both – an individual who has both qualities but these are very, very rare. In terms of economic and funding change there has been a lot of debate on the electronic forums ID Forum and DRS Forum about the number of design graduates that we are actually producing in this country and also in the USA. Obviously, this is partly the result of the huge pressures being exerted at a national, regional and local level. I think this continuous subdivision of design courses is ultimately aimed at obtaining more cash and currently we've gone through a restructuring process. Presently we offer three courses in design and we've been faced with the task of turning those three courses into fifteen courses within a year with no more money or staff and if we don't then we'll be shown the door, frankly. In terms of statistics I would estimate that anywhere between ten to twenty percent (I would imagine that was a good year) of our design graduates actually find work in a design-related field. I would also throw in the caveat that we are actually a very successful design department so those figures are not great - particularly when kids come through the door and say what are the opportunities like? They are very, very competitive. Coming down today on the train I looked through Troutman's Postgraduate Guide at the range of postgraduate qualifications – I completely overlooked undergraduate which I think is four or five times thicker than this booklet here. But the range of postgraduate qualifications available today extend to: DPhil, MA, MA Res, MCA, M Des, MAD, M Ent, MFA, MG Prac, MH Prac, M Lit, MM Prac, MPhil, M Res, MSc, MSc Res, MST, BDC, PDD it goes on and on and on. I don't know how many there are there - maybe twenty different postgraduate qualifications and I think there are at a rough estimate about a thousand postgraduate courses on offer in the UK. Probably more than half of them are in a design-related field. So I think there are massive pressures and change in terms of economics and funds available.

The obvious one and why many of us are sitting around this room today is the blending of computing technologies in and across creative disciplines has enabled designers to transcend what we've historically seen as distinct and separate design disciplines. What I would say is that I had a walk round with

John this morning through the show and I think that is very evident and very clear in the wide range of fantastic and fascinating work that I've seen.

What I was trying to do here [slide] is give a couple of comparative case studies to illustrate what I see as the change or blur in disciplines – what I termed the professional change in an earlier slide. First in terms of the blurring of professional boundaries I think we can observe many similarities today between the working practices of what we would once have distinguished as fine art and what we distinguish as design. I would imagine that most of us, if not all of us would recognise this work. This is the work of Grayson Perry who won the Turner Prize a few years ago. What is interesting about Grayson Perry when you compare it with someone else is that these objects sell for thousands of pounds, they are generally found in prestigious galleries across the globe and in terms of size of batch we are talking small we are talking mainly one offs but maybe limited editions of between one, five, ten. Then, if we look at this work here it has some similarities – well there are a couple of vases at the bottom and it is also porcelain and has a certain sort of craft aspect to it. This work too sells for thousands of pounds each and is commonly found in art galleries throughout the world and similarly the batch is very small – sometimes one offs, sometimes a range of five or ten. But this work is the work of a designer the acclaimed Dutch designer Hella Jongerius. I think what is interesting about Hella Jongerius is that you can now trot along to Ikea and get your very own Hella Jongerius vase for a fiver. But where does art finish and design begin? Or vice versa. Very similar working practices.

The next comparison explores the fine line that I am trying to indicate there between what we see as artists and designers. This is the website front page of Marti Guixe a fairly well known Catalan designer that actually refers to himself as an ex-designer. If we look at the website home page of artist David Shrigley then we can see there are very many more similarities in their work and their working processes than there are differences. It is extremely noticeable that they both have a very similar look and feel. The respective, clumsy, full cap, hand-written scribble is quite close. Similarly, if we look at their work – a lot of Marti Guixe's work is based in the dematerialisation of products – he funds a lot of those sort of exploratory works by his day job which is the interior designer of

every Camper shop throughout the world. Again there are similarities to his work and Shrigley's and some of those similarities include tattoos and also the use of everyday objects in new contexts.

I don't really have any examples to show of economic or funding change – its pretty boring really – let's not get too depressed about it. But in terms of how technology has altered design I think that is fairly obvious. Technology has certainly altered design in the context of this man, perhaps for the worse. Karim Rashid has relentlessly produced blob after blob and he has attracted heavy criticism and I think some of it is just. But there appears no end to the long list of clients that sort of queue up for his services. But I think he's tried to coin a new aesthetic [blobjects or blobism] of blobitecture [Reed Kroloff] or superblob or something.

I think Ron Arad has been a little more successful, certainly more successful critically and I think to a certain degree he has adopted the same or similar technologies to Rashid but perhaps has been a little more particular with whom he works with. Certainly Arad received critical acclaim for his Not Hand Made and Not Made in China series of lights which were produced as part of a V&A exhibition a few years back using stereolithography and I think his use of computers is generally found to be a success. These are only two of the many contemporary designers that rely heavily on emerging computing and manufacturing technologies – the list is endless – Ross Lovegrove, Frank Gehry, Thomas Heatherwick, I could go on.

To finish, I think I have listed a number of issues that as design tutors, design researchers or as design practitioners or as perhaps a bit of all three we would want to consider. That is this notion of do we wish to go down the path of specialisms or should we celebrate the generalist nature of designers. I think also what is local and global and where does design wish to go? There are many arguments for keeping design local and craft-based. Designers are regularly encouraged and frequently have demands placed upon them to be flexible and have greater flexibility in their working practices. Just how much flexibility can designers be asked for? There are questions of intellectual capital versus craft ability and in recent years there has been an emphasis placed on the former to

the detriment of the latter. As tutors we should be aware of prioritising knowledge over craft. Finally, many of these issues have come out of the Bureau for European Design Associations. Designers, design students and design practitioners are asked to trawl through vast seas of data, information and knowledge and help create even more data, knowledge and information and how best can we as designers create environments to manipulate or utilise those vast amounts of data, knowledge and information in a creative way.

9.2 Tavs Jørgensen

Tavs Jørgensen's projects merge traditional methods in furniture making, ceramics and foundry work with new technologies such as rapid prototyping, digitising and motion capture. The aesthetics of his work reflect the construction process used to make them. Jørgensen is currently Research Fellow in 3D Digital Production at the Autonomatic Research Cluster, University College Falmouth, where he is exploring new interfaces between human gesture and computer-aided design (CAD)/computer-aided manufacturing (CAM).

Tavs Jørgensen
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We've already seen a bit of ceramics and I have to confess that is also my background - I am a potter by trade. But a few years ago I got interested in the digital tools that were becoming available for us to create. These present such fantastic possibilities and offer an array of different ways of creating and give such creative opportunities that certainly as a potter I find incredibly exciting. However, there are also things about the practice of working with material and form directly, intuitively and physically which is still valuable. My research is

about how to use some of these fantastic, new digital possibilities but combine them with using them in a much more intuitive and physical way - combining the two methods.

The research started a few years ago with this piece of equipment which is a MicroScribe® – a basic tool for taking data from physical objects and feeding it into the CAD programme. It is a fairly basic tool and it does it very well. But what we got excited by is not only can you record physical shapes but you can also create shapes, use it as a drawing tool to record the motion I do with my hand directly into the computer programme. That to me was far more exciting than using it just to record physical shapes into the computer programme. That movement I've just done with my hand is then recorded like this as a 3D line. Initially, this obviously has not got any solidity it is just a spline, a path you can add solidity through the modelling programme by sweeping shapes through the drawing. These are solid shapes in the computer's mind – you can RP (rapid prototype) them, you can create a physical representation of the drawing through the RP machine. That is what we did with these pieces.

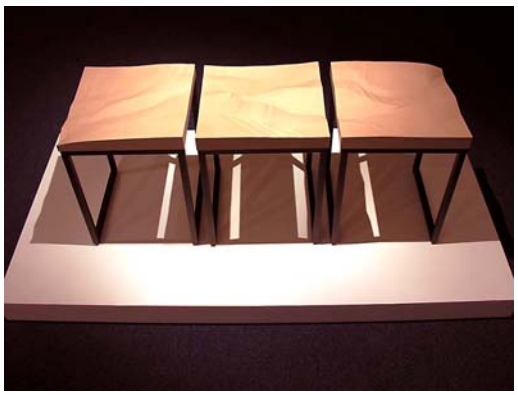
This first stage of the research ended up as awards for the UK Science Park Association (UKSPA) an annual award for the best scientists and these first pieces were used for that set in clear acrylic so they – just like in the drawing package – kind of hover in zero gravity, just like in the computer programme. You can obviously also take that RP shape further into other materials and I've worked a little bit with that. I've worked with a small foundry firm where we took the drawings done with the MicroScribe® then rapid prototyped them into plaster and they burned out the plaster and cast bronze directly into the void and you get a bronze shape from a drawing.

This initial research led on to another project I started with the University College Falmouth part of a competition where instead of just doing the splines and drawings you would use the splines and drawings for actual physical pieces. Again, going back to the potter in me I was thinking of vessels and using the splines to create the vessels with. We got hold of another piece of equipment. This is called a ShapeHand™ - a motion capture piece of equipment that is

mainly used in the animation industry for recording the movements of an actor and then you would use that for special effects in a film.

It works on the basis of fibre optics and records the curvature of how the fibre optics bend and translates that into the movement on the screen so you can really record the dynamic movement of your hand. You can really use this to describe shapes by your hand in space and record that data as linear paths just like the MicroScribe®. You can have much more dynamic paths using all the digits. Whenever we discuss shape nearly all designers and makers always use our hands to gesture and explain things by our hands. So this research is an attempt to create using our hands and using that tool.

The splines are recorded and from the splines again you can create surfaces between the splines. Once you have surfaces you can process it again – you can RP or in this case we used milling. We milled out the representation of the movement of the hand. Initially, we used ceramics as pots – the interesting part is that you are going from digital into physical objects. The digital part is really quite easy. Once you get to the physical part it gets difficult. Creating moulds for such complicated, random shapes is very difficult. I did a few pieces that weren't very successful. They were very difficult to produce. At the moment I'm trying to find different applications for using the glove and the hand to produce shapes. What you will see in the exhibition is some stools that I think are much more successful in the way it has been used. The surfaces have been milled from the forms created and there is no subsequent mould making. It is also quite interesting to experience something not always through your hand but through other parts of your body. They are still flat enough to sit on and be comfortable but it is interesting to find a place to sit. The movement of the hand is a long movement across the three chairs.


Motion in Form

There are issues about creating surfaces between the splines and in some ways these surfaces are artificial. You are just saying ok I want surfaces between the lines but what you really are recording is just the splines. So the next part of the research is to work with the genuine data, the genuine intention or recording from the hand. But it is quite difficult with five digits – for some objects it is too much. So I have gone back to the MicroScribe® to use that to scribe a rim of a vessel or a loop. To draw a loop in air - in many ways - is all you need to describe a vessel, just the rim. How to process that was another issue. Milling is great but it is quite cumbersome and you have to remove an awful lot of material. You can use rapid prototyping but it is quite expensive and it can be quite slow. So finding a way of representing these lines, of the rims of vessels possibly was another issue. This method came about where you draw the line in space and you can extrude it down so it becomes a surface. You can then unfold the surface and all of a sudden you have a very simple representation of this 3D line from the 2D representation of the line from the top and the 2D representation of the line unfolded from the side. By putting those two together you get the 3D information of the line. To do that physically, to create physical form you would use laser cutting – now very accessible and relatively cheap and you cut out the shape of the line.

This is done in very thin stainless steel and you force the line – the collar or the unfolded line into the top section and all of a sudden you've got the physical representation of the 3D line. You set it in plaster and you can place a disk of glass onto it. As you heat the disk of glass up it will go soft and gravity will mean it will gently flow down and sit exactly on the rim of the collar. You have created a piece that both represents the digital recording of your intention but it also

uses the physical nature of the glass. i.e. it gets soft and is formed from its own heaviness by gravity in the kiln. You have a piece that looks like this – the dome created by the soft glass bending in the kiln. This is unexpected where the glass kinks over the edge it creates a dark edge that is very clear to see that 3D line and also as you photograph these pieces the dome of the piece in the middle almost becomes invisible so you can almost just see the line there. The rest of the glass just sort of flops over and it is quite nice just to have an element of the material doing what it does. You can't control it – or there is not much control there. But you can also trim it back so you have the bowl exactly to that line and you can see these pieces in the exhibition as well. Again, the bowls become almost invisible as you photograph them as the light goes straight through them - so you only really see that line from the drawing in the pieces.

Motion in Form

Another step further to finding genuine intention or the genuine data of when you are recording is using the point data. The lines in some way are a little bit of a fraud. The lines are calculated by the computer - it kind of helps by doing a line between the points that are recorded. So really all you are recording are coordinates in the space. Instead of using the linear data you can also use just the point data and that is very accurate in terms of what is really recorded of the movement of the hand. Again you can use that – instead of using sheet metal you can use rods set in a laser cut, cardboard section with holes pierced by the laser. And then to the line of the template again place a disk of glass and heat it up and you end up with a piece like this so that you get that dot data. Again, the material does whatever it does during the heating. It really is a combination of the digital recording of the motion and a material doing things in the physical world.

A slightly different approach that was also part of this project was to also record everyday motions with your hands – so I recorded the motion of drying up. Taking a mug from the draining board, and a tea towel and you wipe it. So that is a recording of me doing that and then taking the mug and putting it on the side. Then taking this information of the recording of the motion, the action recording it as lines then digitally printing out tea towels with the motion of using the tea towel transposed as a decoration. That is essentially what my research is about.

9.3 Aoife Ludlow

Aoife Ludlow is based in Belfast, Northern Ireland and works as Research Assistant at Interface: Research in Art, Technologies and Design.

Aoife Ludlow
www.aoifestuff.com

Hi. My name is Aoife Ludlow and I'd like to say thanks to Fast-uk and folly for inviting me along. First of all, when I started thinking about what I was going to say about 'Perimeters, Boundaries and Borders' I had a bit of a panic attack. Then I thought about it a little bit and started thinking about my work and eventually realised that even going back quite a bit that pretty much everything I'd ever worked on had some kind of a border or a boundary somewhere that got a bit blurred and a bit confused and that seems to have been quite apparent in the last couple of years.

I started off studying Embroidered Textiles and what really drew me more into technology initially was the fact that I hated drawing. I wasn't very good at it and I was in a class of really, really good drawers. Any way I could find a way of

avoiding using a pen and paper sounded good to me. So from my point of view, beginning in college I was drawn to technology. I suppose as well that I never really felt that I was crossing any kind of a boundary because the origins of computing are in textiles. If you go way back to the punch card systems of a Jacquard loom it is kind of where it all sprang from.

So I used a lot of basic things like Photoshop and stuff like that was where I started in college. As I worked at that I moved into 3D, so I did a bit of 3D modelling in my undergrad days. So this is some from my degree collection where I moved into designing more sort of sculptural, and into more jewellery-based work. I had already moved away from textiles before I'd even finished the course – this is all paper, plastics and metal work. Maybe it is just that I get bored really easily, I don't know. So that was where I started and from there I went on the digital thing became more and more part of my work - digital imagery in particular and I started getting interested in animation so when I finished textiles I went on to do a Masters in Interactive Media. Again, I never really felt I was stepping outside of my box all that much until someone in one of the first lectures – we were introducing ourselves to the lecturer - and I said I'd studied textiles and he said "Is that a degree?" Maybe I'm not in the right class after all. So that is where I am coming from.

I am interested in ordinary, everyday things. Again it goes back to that I get bored easily – I'm interested in why I get bored, really banal things tend to interest me more than they should I suppose. This is a quote from Georges Perec that I like:

> "How should we take account of, question, describe what happens every day and recurs everyday: the banal, the quotidian, the obvious, the common, the ordinary, the infra-ordinary, the background noise, the habitual?" Georges Perec.

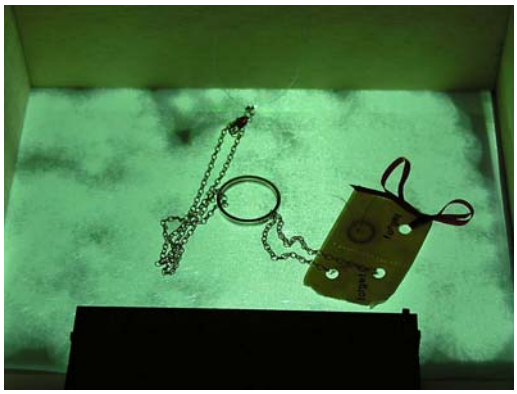
It is about the everyday and the obvious and things that we don't notice and things that we do all the time. And this again is related back to working in jewellery. People ask me what do you do and I say I make jewellery and they instantly look at your hands to see what you are wearing. Or they look at your neck. I never wear anything I make. I don't even wear much jewellery – I

automatically put on those three things every morning and I never even think about it. I make things for other people to wear but I never think about what I wear myself. So this is where I started thinking back to it is all so much habit. It's just something I do it's ordinary. So I started to look at these habits, look at my own habits – what I was wearing and why I was wearing it. This was at the same time as working on the course on interactive media so as my thesis project these three questions came up: how do you change your habits? Or what if you want to change a habit and you don't really know where to start, especially when it comes to something that you wear. I tried to stop wearing things for a while and see how it made me feel – it makes you feel a bit naked without it - it feels a bit odd leaving something that you wear every day and not putting it on. Could a piece be more adaptable to change? Could things that we wear reflect change or different habits – when you do wear them or don't wear them or why you wear them? If you had some way of reflecting on these habits could that encourage you to remember these habits more or to think about them some more or could it make you forget or change your habits in some way?


Remember to Forget?

This is the piece that is showing at the exhibition called 'Remember to Forget?' It started life as a series of questions and this is what it has developed into – it has been through a number of incarnations. So it is a piece of jewellery and a jewellery box. When I was thinking about my own habits – the only time I notice these couple of things that I wear every day is when I put them on in the morning or when I take them off. When they are actually on they fade into the background. This is where the idea came of holding the point of putting on or the point of taking off – I always leave them in the same place every night because they are important and I don't want to lose them. They sit in a box or

they sit in a specific location always when I take them off. So something inside the box would reflect how you wear things or why you wear things. It has been through a couple of different versions. The first piece was a modular piece that if you wanted to stop wearing something but it was hard to just take it off and go and put it away so you could gradually deconstruct the piece and put it away a section at a time. The significance of these pieces they are often related to many memories. Each module of the piece was connected to a photograph, something to do with that piece or some memory associated with that piece. The box displays these photographs so long as you kept wearing each module but as you started to put pieces of it away or leave them in the box the photos will fade away gradually to reflect that move or that change in your habit. Another piece actually took a physical record of times and dates – a very clinical, hard-nosed approach – so you could look at your diary of when you wore these pieces or didn't. The third piece which is the piece that is in the exhibition was kind of a more abstract piece. It is a very slow and gradual animation that builds over time to display more and more light over time so the longer you wear something, the longer it is away, the longer it is on your person the more important it is so the box reflects this by glowing more and more so the longer you wear something the brighter the glow from the jewellery box. If you put it away for a long time the animation gradually blurs and fades and disappears. So if you wear something like a bracelet that there is a predictable pattern it will glow to a certain degree and go back down in a steady pattern so if your pattern changes so does the light coming from the box.


Remember to Forget?

It is a very simple piece – it is not very complicated technology in any way, shape or form. It is done with Director and Processing and at the minute is

using RFID as a sensor mechanism. I'm no techno-nerd and I'm not very good at a lot of that kind of thing but it was just a way of exploring the idea more so than wanting to use technology and I suppose that is what I think it is all about - just finding the right tool for the job. In this case and with some other work I've been doing technology, software, programming, whatever has been my tool and it has allowed me to express those ideas – that I how I feel it should be used not technology for technology's sake. Which particularly in the case of a lot of wearable technology that has shown up in the last couple of years it is really about "Wow we have this technology – what can we put it in?" It is just an attitude I don't like. For me it is about the slow and the simple, the ordinary and the everyday.

I currently work at Interface at the University of Ulster it's a new research centre. It has two parts Art and its Location which is the more fine art strand and Art in Public which is broken into Art in Contested Spaces – we're based in Belfast so it's not too hard to find a contested space – and Art and Documentation. I'm a Research Assistant with Fabric Forward and the very fancy name they've given us is Hybrid Textile Configurations, Customisation and Construction – please don't ask me what they mean. I'm just going to run through a couple of the things we are working on at the minute – the more programming based work like 'Remember to Forget?' has taken a bit of a back seat for me at present because of other projects. These are all group projects – we are running a series of master classes inviting high level professionals in different fields to come and work with us and the equipment that we have around themes. The first one of these was Contemporary Souvenirs and we had Peter Ting who is Aspreys homewares designer and also designs for a number of other people, Dierdre Nelson a textile artist based in Scotland, Clare Grennan who is a jeweller and then the rest of us (Interface staff) are textile based. So this is some of the work from the very first workshop exploring notions of Irish souvenirs. They look like very ordinary things, probably but it was more about process. The whole thing about Irish food came up and the fact that Irish people when they live abroad always send home for their tea, their Barry's tea, their bacon and their potato bread. So on the right are just some crazy tea bags, printed with all kinds of text and they were just some good John Hinde's photographs printed on tea bags. The top left is some ground up, local peat just

cut the day before that has been screen printed and flocked onto a linen tablecloth. We also made some tea towels that actually made tea – we printed tea and made tea with the tea towels. The bottom image here is actually sugar that has been flocked on and then it is laser cut so that when we opened the laser cutter we had this beautiful smell of caramel in the whole building from laser cutting the sugar. Some of this work has been developed into more practical things. We have had a second round of workshops working with a small number of manufacturers and craft workers in Northern Ireland and some of the work will be exhibited next year at the Smithsonian Institute in Washington D.C.

One of the other projects we have been working on with the Helen Storey Foundation and the Polymer Centre in Sheffield it will be three exhibitions in the coming two years looking at ideas – there are two parts to the exhibition – 'Wonderland' and the other part is called 'Ideas That Could Change the World'. It's all about recycling. The Polymer Centre are working on products from new polymers, new plastics mostly ones that will dissolve in water and can then be reconstituted. So a thing like a bottle that when you are finished with it can be washed down the sink and is extracted in the sewerage system and can be recycled in that way. It is just making recycling easier and trying to make it not so much of a chore for people.

The part that we are involved in is kind of the press puller for the exhibition one of the more practical applications is a series of seven dresses that will dissolve in large tanks of water over the course of three weeks. So by the end of the exhibition there will be seven tanks of water where once there were seven dresses. It has been really interesting to work on because we are trying to make all these beautiful things but once we have made them we then have to think what happens when we put them in water. It has to look interesting when it goes into water. We have been making things and destroying them on a daily basis which was tough to come to terms with at first. You spend four hours making a piece of fabric (a 2m square piece of fabric or whatever) and when it is finished you pick it up, put it in a fish bowl and watch it disappear. Technology has come in in a big way in that all of a sudden video has become of massive importance to us. So that we have to video and photograph absolutely

everything and then we've got to study the video to see what works and what doesn't work. It's like trying to design from all angles.

The photo on the right was the first full garment we made up. The left is just two fabrics we were working on. We actually showed that at Siggraph in Boston this year at what used to be called the cyber fashion show which thankfully it no longer is. So that was really interesting - we got quite a reaction from people who didn't know what was going on when she started to drape her dress into a large tank of water.

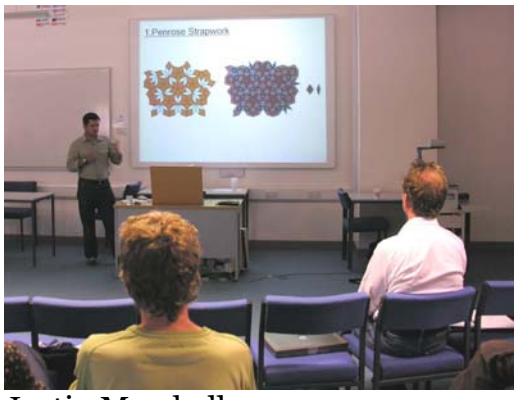
I'm also involved in something else that crosses some boundaries. A group of us in the University got together over coffee and decided to do a bit of work together. We are called Call Centre Collective because they shoved us into an office space that really resembled a horrible call centre. Ruth is an architect, Saoirse is a new media artist but she used to be a product designer, Doris is quite a traditional fine artist a painter and printmaker, Emma is a textile artist and then there is me. We are involved in quite a large community project at the moment. Donegall Pass is a very tight, small, inner city, working class, very loyalist community in Belfast which is under a lot of pressure - because it is a prime place in the city centre – from corporate developments on all sides. There is a site at the end of the Pass which is derelict. The Regeneration Officer for the area is currently in talks with the Housing Executive about trying to negotiate that the community will take on this site to develop it for themselves. There is a big problem with housing in the area. The Regeneration Officer came to us after hearing Ruth talk at some City Council event and asked us to come down and do some work in the community. Not to do a participatory design process but to try and find ways to involve the community so that at some time in the future they would be ready to take on a cooperative design project as part of the regeneration of the area.

We have been down there for about five months off and on, getting to know people, looking at the area and thinking about things. As a way of launching ourselves into the whole thing we got involved in a project called Space Shuttle - which is the silver box there. It is a model of a gallery space in Belfast, part of a different project that we have pulled into this one. So we were down in Donegall

Pass at the end of August for ten days running a series of workshops and events - all kinds of different things to draw the community in and get them talking. We took the whole theme of space and the space shuttle as a way of engaging them and talking about space, and talking about their own space. So some of the images there are from one day we spent making space suits with a group of kids as a way to engage them to talk about survival and what it takes to survive in Donegall Pass and what kind of things they need out on the street which is where those kids spend a large amount of their time. We sent them off to record sounds of the street and then we broadcast from the Space Shuttle. We also made a space walk and this was the last day [Video].

9.4 Justin Marshall

Justin Marshall's practice spans sculpture, installation and design. Much of his recent work has been ceramic or plaster based, combining traditional skills with new technologies. Marshall is currently Research Fellow in 3D digital production at University College, Falmouth. His most recent exhibition was at Das Keramikmuseum Westerwald, Hoehr-Grenzhausen, Germany, and in 2005 he was awarded an Autonomatic research grant to work with Hayles & Howe decorative plaster company to develop new processes and work.



Justin Marshall
www.justinmarshall.co.uk

I'm a research fellow in 3D digital production at Falmouth. I work alongside Tavs and two other researchers and we are interested in some of the things that Paul Rodgers mentioned earlier. One particular area of concern is the connection between the use of digital technologies and craft practices; how new

forms of digital production might aid the development of more sustainable forms of craft practice.

This project came out of the Autonomatic 1 symposium run at University College Falmouth early in 2005. This [slide] lists some of the issues that the Autonomatic competition sought to address, the specific questions I attempted to address are at the top.

I've been working with digital technologies for quite a number of years on and off, from the perspective of a maker/craftsperson/sculptor. I have also been interested in the integration of craft practices into architecture. So, I wanted to try to work with a related industry, to see how my skills as an independent maker that uses digital technologies may impact on their work practices of a company that makes ornamental plasterwork and uses predominantly very traditional craft processes. I also wanted to look at how my practice as an independent maker – as Julian flagged up earlier – might be made more sustainable by finding some sort of practice that involves working in collaboration with industry without being a designer just embedded within one company.

Hayles and Howe are a Bristol based company. They make this sort of thing: cornicing, ceiling roses, strapwork ceilings – everything from domestic, small scale stuff to large scale, multi-million pound restoration projects and new build tends to be retro stuff. You can see here that apart fro the use of silicone moulding rather than gelatine moulding and other minor stuff that their practice hasn't changed hugely, certainly since the Nineteenth Century, and perhaps before then. So this is the sort of stuff that they would routinely produce, this is Sting's music room ceiling which they produced, which is a new design, but very much within a genre - using very traditional, hand modelling skills and moulding and casting.

I approached the Managing Director and described who I was and what I wanted to do. I wished to undertake a number of small scale projects that investigated using different forms of digital production technology, and to see

what functional use they might be to an industry that has no use for digital production technologies at this time - everything pretty much is hand done.

There are four projects and I'll quickly run through those. Alongside my interest in working with industry was developing designs that are modular and allow flexibility within the arrangement of things in order to let users have a unique product or a unique outcome through providing units which can be arranged an infinite number of ways. Roger Penrose developed the tiling system on the left in the 1970s which allows that. It is called an aperiodic system because it allows the arrangement of basic units in an infinite variety of ways, so that you can produce an infinitely number of different designs which will always tile a plane completely. So you can see there through putting a pattern within those tiles you can develop new forms of patterning which can be quite symmetrical but also be completely random. These designs are based on the two tiles you can see at the bottom of the slide. These designs can obviously be modelled three-dimensionally within a CAD modelling system.

In terms of computer output none of what I have done is very high tech at all. I purposefully tried to keep these strategies or methods I developed quite simple so it wasn't going to scare people into thinking "Well I'm a plaster maker, I'm not a computer modeller." Actually, the only computer controlled equipment I employed in this project was a CNC milling machine to cut profiles for a traditional plaster spinning process. On this slide on plasterwork development, you can see the CNC the milled metal profiles which can be used to spin plaster circles, or create 'runs' if you want a straight elements in a design. These were just tests for me to fiddle around with, I actually use a slightly different method of cutting whole circles at specific angles which then fit together to create the same designs as you would get using the individual tessellating tiles. So this is what is installed –or something very similar – in the show and these are the units used to put it together. This slide illustrates the first exhibition that I showed the piece at. So although the underlying structure of this work is an aperiodic tiling system you can't see this in the finished work, you just see the overlaid pattern. You can just about see my layout lines there and so the underlying tessellation. This is a different design based on a slightly different pattern within the tiling system.

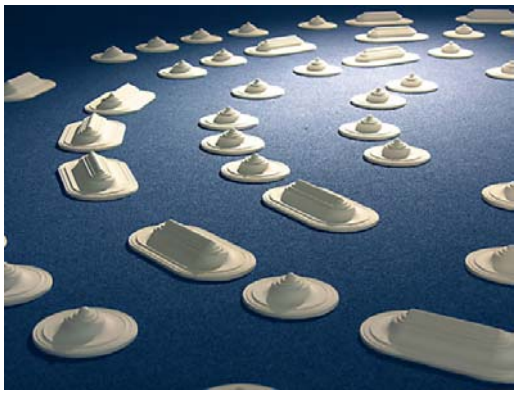

Penrose Strapping 1

The other project was trying to not use any sort of 3D software at all, but just use very simple, image-based software. In addition it did not use any sort of drawing, I used text to generate a pattern in Illustrator which I arranged to produce a section for a repeat for a ceiling rose. From a greyscale image, which in quite well known and easy to use software, a low relief form can be created and then CNC mill the reliefs to produce new designs. This is something that is used very widely in all sorts of industries but wasn't known by this plaster company. Again, I wasn't inventing anything I was just applying existing methods to a new area. That is the final result shown alongside a traditional ceiling rose produced by Hayles & Howe. It was trying to get them to think that using Photoshop and Illustrator isn't so difficult and you can see some sort of 'in' to producing 3D form through this sort of system. rather than thinking "I've got to go off and learn 3D Studio, or other 3D modelling software."

In another project, I used a different form of digital output as well as not using any three-dimensional modelling software. I used Illustrator to produce another modular pattern which allows people to create a sort of low relief drawn line wandering around a room. It's like having a cornice going off one wall and coming down another, going round a sofa, along the floor and back round the ceiling. It allows you to draw in a 3D space using very simple units. The units were made up of laser cut in layers. So everything was 2D. The cut elements where reconstructed by hand into a relief which could then be cast to produce units which could then be configured in an infinite variety of patterns.

The other project was the 'Morse' project which again there is some of it showing in the show. It was a quite light hearted thing really, about the nature

of ornament and the fact that a lot of ornament that was used at some point had symbolic significance and that now has slowly disappeared into the mists of time and we just use classical forms in quite an ad hoc way. Morse code is one of those things that has lost its ability to be read to some degree. So the idea that you could use this as a decorative order and be quite abusive in a ceiling decoration and actually most people would read it as an interesting kind of visual aesthetic layout. The master models were CNC milled again. In my first exhibition I had them strung up so they could be rearranged and we had kids' workshops and I was trying to encourage them to start rearranging these elements into whatever texts they might wish to do. Most of them couldn't be bothered. It was a light hearted idea of fridge magnet poetry but stuff you couldn't read.


Morse

So these four projects have been running over the last year or so and culminated in this exhibition, (that most of these slides are from), held in Bristol over the summer as part of Architecture Week. We are now getting to the point, both me as a maker and the company are reflecting on the experience of me working with them. Trying to see what has been useful in terms of extending my practice beyond my capabilities as an independent maker by working with industry; to make things at a larger scale and use skills that I haven't got, and what has been useful for the company. One of the functional outcomes is that they are interested in laser cutting and they are looking to adopt this technology in certain types of production. However, this is not considered as a technology to replace their clay modellers, but a method by which they can transfer their skills to something more complex and creatively challenging than modelling very straight and angular elements in clay, which is what they do at the moment.

Hayles & Howe and myself are trying to develop the Penrose Strapwork into much larger units which can be configured in an infinite different ways to make a viable product. This would have an impact on me as an independent maker – it would have some financial benefit to me and they would increase the range of what they do. My new designs aim to hit a market based around modern, contemporary architecture, rather than restoration and esoteric and peculiar rich Americans who can afford to reproduce classical rooms on a very large scale, which is Hayles & Howe's principal market at the moment.

So that is where we are with the project at the moment. I will be continuing to work with the company and try to develop some more financially viable products and instigate new commissions.

9.5 Lionel T. Dean

In 2002 Lionel T. Dean was appointed Designer in Residence at Huddersfield University and began working on FutureFactories, a digital manufacturing concept for the mass individualisation of products. FutureFactories has had exhibitions in London and Milan. Previously Dean worked as an automotive designer for Pininfarina in Italy, before launching his own consultancy business.

Lionel T. Dean
www.futurefactories.com

Good afternoon ladies and gentlemen my name is Lionel Dean. I am a practicing product designer, I have my own practice, I am also a researcher – I am studying my PhD at the moment, and to some extent I am an artist, as well. Back in 2002, I had the opportunity to do a one year design residency at the University of Huddersfield. I wanted to use the opportunity to look at what

might be done with rapid prototyping techniques. Obviously in my design business I had come across rapid prototyping and the use in the design process. But I wanted to see what could possibly be done with this, what the future of this could possibly be. Whether you could use this for production for rapid manufacture and if you could use it for rapid manufacture whether you could use this to individualise products in some way.

With rapid prototyping techniques the cost is based on the size of the model – on the height of the build chamber – and it doesn't cost you any more to produce two things that are similar in size but different shapes than it does two that are exactly the same shape. So the economics of mass-production don't apply here. So could you produce an infinite stream of products that were subtly different in the same way that you probably would historically as a craft maker making things by hand. Things that vary slightly, might vary a little bit with the material you are using or you might feel a little bit differently and tweak something on the day and somehow there'd be a little bit more of a human element to the product, there would be a bit more character of their own. Perhaps this would be something you would want to treasure and not throw away because there wouldn't be another one quite like it. It would have some sort of personal value to you.

How this would be done would be using a combination of rapid prototyping and parametric CAD. Parametric CAD is just CAD where objects are defined by relationships between different values rather than absolute values. So you have a model there and if you change the length the whole model will update to accommodate that. So you can have a situation where this model here [slide] - each one of these tuber forms is defined by a series of cross-section circles and a skin is then generated between them. Then you can tweak these circles, you can twist them, scale them, translate them and the whole for will update accordingly.

You could have a situation where you have a factory or a production line and there is a designer sat at the end at his CAD screen tweaking the model each time. But that would not be an automated process – it would fall down – because you are relying on the skill of the craftsperson still to be sat there with

his computer. I wanted to try and automate this system. I wanted the designer to be able to define a set of rules for this object so you almost choreograph this like a movie. You then set it going and then it carries on in its own sweet way generating design after design. But each one, hopefully with the rules that you have set is still true to the design direction you wanted to give this product in the first place.

When I started off I thought this was a blue skies research project (back in 2002) then in 2003 Materialise showed their first collection. This obviously pointed the way that this actually wasn't so far away in terms of the rapid manufacture being already viable as a production process – albeit yes it is expensive to design objects but in reality the prices of the lamps that Materialise sell aren't too different from the high end Italian manufacturers: Artemedia, Flos – they are comparable in terms of price. So this is a viable process already and that made me rethink slightly how far away this was and maybe it wasn't a blue skies project it was something I could start doing straight away.

While I was generating design outputs for the project I also spoke with Materialise and we started working on a couple of projects and we productionised a couple of designs. The first one was RGB which is based on the tuber forms - this is it in laser sintered Nylon. They wouldn't think about individualisation just yet I'm still working on a company to work with on the idea of individualisation there are a lot of hurdles to that which I will come to. With this particular one the software was there to generate the form we produced – four different ones, but four is as far as they want to go for the time being.

This is Creepers and the idea of this one is that it is a series of petal forms and the petals catch the light from some very tiny LEDs just 5 mil LEDs. The idea is this creates a space divider or room divider with light. Really the idea here was the idea of generative design and forms evolving to create this pattern making the leaves different with each cluster.
This year I worked with an Italian manufacturer Kundalini and we produced this table lamp for them - Entropia. This is quite a leap forward in terms of the industry because here is a company that have nothing to do with rapid

prototyping. Materialise started off because their lamp division is actually a very tiny division of a huge company that markets software and is probably I would think the largest manufacturing bureau in Europe. For them it is a little bit of advertising and at the same time they have a vested interest in the technology that they are trying to promote. With Kundalini here was a company coming to rapid prototyping for the first time they hadn't used it in development before. They were purely interested in what they could do with this in terms of form. And what they wanted to achieve was a form that would baffle people - that people would have no idea how to go about manufacturing something like this. They didn't want any rules, patterns or repeats that anyone could identify. At the same time, as a slight contradiction to that they wanted it to be obvious that there was some process behind it – they didn't want something that was just random because they didn't think that would have a perceived value. So they wanted some evidence of process but you not to be able to figure out how that worked. It was a tricky brief to deal with in that respect. But what I wanted to do and what I ended up doing was applying the rules and relationships that I used to generate the FutureFactories collection but rather than changing the overall form I was changing components within that form. So it is a tree or bush-like form made up of a number of different components the circular ones I thought of a flowers and the rest are leaves. The flowers have a hole in the middle and the stems curl back behind that flower to block up the hole so you can't see directly through to see the light behind. But there is a lot of room to manoeuvre with that form in terms of how it can change. So I think that the flowers – there are around two hundred in the form and every one is different. In the whole form there is something like a hundred chains of components - the chains are about twenty elements long. There are a lot of different components to the design but we set up a number of rules so each of the components would change every time and then we used that to generate each different one as we applied it.

This brings me to the project that I've done for this exhibition I wanted to use the opportunity to work on something on a slightly larger scale. And also I had been thinking for a while about the notion of using the potential of reverse manufacture – designers taking on other people's designs and adding bits to them or if you had an artifact at home maybe instead of chucking the thing away

when it breaks maybe it can be modified in the future so you might have something that gets renovated rather like architecture where you get bits added to it from different periods to an object. There are also very practical issues it is a very large piece to have manufactured so I just wanted to stick with just the back and the arms. The idea was to take an iconic chair – Starck's Louis Ghost chair fitted the bill quite well in terms of it being a chair that a lot of people would recognise and being transparent it was a nice sort of plinth that didn't dominate the rest of the work. The idea was to chop the back and arms off and replace those. The back and arms would just squeeze into the largest laser sintering machine that is available at the moment. There are larger SLA® machines – you might have come across the work of Patrick Juin who has done a chair with Materialise which is longer in terms of the bed length but it is SLA® and it is functionally not as strong. It is very much an art exhibit as opposed to something that is functional.


Holy Ghost

So, off go the back and arms and the one you'll see down in the exhibition is this one here. The back form is taken from the idea of button leather and each one of these 'buttons' floats independently. The arcing ribs you see across the back all act as springs because the Nylon has flexibility and so they'll all float independently. Rather like a spring mattress you lean back into this and it adjusts to fit your back. This is where I come into the argument about random design and do I do random design. My argument is that I don't produce random designs I try and get generative software to produce iterations of my designs but I don't feel they are random. I think ordinarily when you do a design process like this when I had this idea in my head and started sketching this thing out there is a point where you say to yourself "how many buttons?" I think I started

off with twenty two. I think that changed with the first version to twenty four. But that is not really fixed it is slightly arbitrary. With the generative software what I've ended up doing is giving it a window – I think that with the version we have now it is anywhere between twenty two and twenty eight. Also, the position of those isn't terribly important. First of all, I started off positioning them at random and then spreading the forms out and seeing how they looked. Again, the positioning can be part of the programme.

I'm working with a software development tool which simply gives you a nice little halfway house between programming and something that is a little easier to work with as a lay person. What it is doing to start off with is positioning the buttons at random. First of all it has already decided how many buttons there are going to be and it is now trying to position them so it is dropping them into place at random within the envelope of the back. If it clashes with one of them it removes it and moves it to another position. It will do that until it has the right number of buttons and then they'll begin expanding.

One of the problems of working with rapid prototyping – I thought when I'd moved to rapid prototyping that it would be great you'd have bureaus produce endless samples for you and you would be able to do this as an iterative process. But in fact the cost of the process means that very much you end up doing this in one hit. With this chair we had structural implications with those springs in the back to work out how stiff they needed to be. The whole thing had to be done pretty much in one hit. We did talk with the University about doing this with Finite Element Analysis to try and work out the stresses. But it is such a complex problem in that the way you sit in this your weight is spread across the entire back of the chair and it is a very difficult problem to work with. Fortunately, it came out first hit.


Holy Ghost (detail)

It is very different to how things used to be where normally I'm working on a design project I had to have a studio full of bits and bobs and models at various stages of this project - physical models – whereas now I'm seeing the thing on the screen the whole time. In fact with Entropia the prototype was built out in Italy I didn't see the models until long after the client had seen them. Which is quite an eerie feeling when the client – you are talking to the client on the telephone – he's looking at the model and you are not you're seeing it on the screen but it's not quite the same thing.

So this is the model as it ended up. It is quite an interesting to work with something other than a lamp form. SLS® is – if you've seen the process – it is a textured finish that you get with this. It's fairly rough and ready and interestingly enough I was at a conference last week the TCT (Time Compression Technologies Conference) where they were talking about the future of rapid manufacture and saying that the big hurdle is the finish of SLS®. I was saying in my talk how beautiful the finish of this was because as a designer working with objects that are on the art fringe it is a very beautiful material. Particularly when you use it for lighting because when it is back lit it is almost like a wood grain finish. The problem with it is it being a textured finish it picks up grease basically so if you handle these things they do get dirty over time. Also they are UV sensitive so if they are in strong sunlight they will yellow over time. I think there are a lot of people out there with nice expensive lights that maybe in ten years time will be a bit sort of nicotine yellow.

Finish is one of the big issues it would be nice to have a really nice glossy finish you could achieve via rapid prototyping. The first objects I did were hand

finished that was necessary because I was using some of the cheaper 3D printing processes. So to get the exhibition quality I had to use hand work but really then the whole model falls down if the idea is the designer sets up the template then manufactures straight from the computer. If you then take them back and do a whole lot of hand work on them the whole model falls down. So that had to be avoided. Then with the raised profile of the project and the backing that that brought it was possible to use some of the more exotic processes and so went into SLS® Nylon and you can see in the close-up there the texture that is coming through from the rapid prototyping. Which in lighting is a very beautiful finish but not quite so applicable when you see it in an object like a chair. That is a close-up of Entropia again you can see the striations the lines from the process. And that is where I am at the moment.

9.6 Human Beans

Human Beans create provocative concepts. They make fictional products by hacking commercial culture and design new services by working with real people. Their work is disseminated through spam, media, shop shelves and exhibitions. Human Beans is a collaboration between advertising creative and designer Mickael Charbonnel and design strategist Chris Vanstone. Their work was recently included in the HearWear exhibition at the V&A, London and Safe: Design Takes On Risk at MoMA, New York.

Human Beans
http://www.humanbeans.net

CV: We are Human Beans. I'm Chris...

MC: I'm Mickael

CV: …and we are five this week, did you realise? Five years old. Your Grandmother's special recipe – who's going to volunteer their Grandmother's special recipe? [Apple Crumble] That's a good one. Anybody else? [Soda Bread] That sounds good. [Rice Pudding] Over the last month or so we've been filming and editing the Grandmothers' of Lancaster cooking their special recipes so we are going to kick off with a film of one of those Grandmothers – it's about six and a half minutes and then we'll come back and tell you more about it.


Jackie's Scones

[Video]

MC: Did you see the size of those scones? You could do the same at home. We didn't try yet but we'll try to imitate that at some point if we have a big enough oven. Our dream with this project is to actually manage to collect recipes from Grandmothers all around the world and create a video cookbook online of all their recipes and all their different ways. The thing with those recipes and Grandmothers is that you never know how much you should put in the bowl; you never know what quantities they are, you don't really have any reference points because they have done it for so many years now that they just know. They don't really measure anything, they just throw it in and it turns out right. Hence the idea of actually filming it so that you can just replicate exactly what they are doing. They have been doing that stuff for many years and gradually the recipes became their own thing. They became their own personal recipe they are not really sometimes even that traditional any more although they still have the traditional name. That is why we had to go in their own kitchen and we had to collect the real stuff. Imagine now if we can put this online and you can

go inside those kitchens and really find out how people really do things and how people really live. This is the obvious benefit of this project I suppose is that you get this knowledge that our Grandma's guard in their kitchens. The other thing is you get the opportunity to connect with a generation that you do not often get to connect with outside your own family. The nice thing in this is that we can provide a way to connect - an interface for people to connect with an older generation. Chris is going to tell us a little bit now about what we have done in the past and how that connects with this new project.

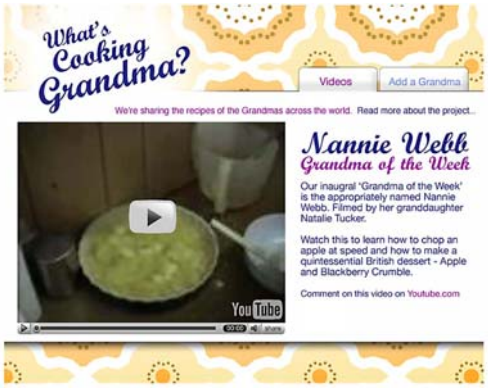
CV: First of all what I wanted to say at the top was thank you to Fast-uk and to folly for giving us the opportunity to get this project off the ground. It is something we'd been talking about for a couple of years and this is the opportunity to get it going. So I'm going to show you some of the things that they probably thought that they were getting when they asked us to do this work.

So that is Karmaphone [video]. Karmaphone is a phone that through karmic vibrations that you can use to control your mood. This is one of our series of fictional products that we did that are also represented as short, little films that we did on the theme of well-being. These projects are really about creating (Karmaphone in particular) a critique of what might be done with technology and the market's blind faith in the possibilities of technology. What we wanted to do with this project was something different actually. We wanted to see what we could do with existing technologies: with the stuff that everybody owns. The stuff that is in mass ownership and rather than create a critique, create something that is more constructive and see if we could create a product that could be made by people themselves. Technologies that were once bleeding edge and in the domain of professionals are becoming, or have become in some instances, commonplace and affordable. So if you think of home video making that is one example, photography would be another.

The democratisation of these technologies leads to the generation of new cultural literacy's. So I guess what we were trying to in this project was to connect the popular literacy of cooking with the popular literacy of home video making. The first home video recorder came out in the 1980s and now if you

think about it you can not only edit and direct your own movies but also through things like YouTube™ distribute your own movies. That is a significant step that now you are in charge of distribution, you can literally as YouTube's strapline says "Broadcast Yourself". These sites are really growing they are the fastest growing sites on the web – and yes TV programmes use them to syndicate their programmes and brands come and use them for viral marketing. But by far the biggest bit of content on there is generated by users themselves. This has led to the creation of new genres which are quite interesting. There is 'drunk lip-synching' that is two girls, usually two girls that come home late at night in front of their webcam and film themselves singing along to their favourite tunes. This [slide] is the 'Urban Ninja' this is a twenty to thirty something male that dresses in black, goes out into the park and jumps out on people. I don't really know the origins of this, somebody might know – I see some smirks – maybe it was you that started it but this stuff has been copied loads of times. People have put these ideas out there and people have copied it and we just wanted to see if we could do anything in that space. Of course the most infamous genre to be created through this is 'Happy Slapping' where a gang of youths gang up on somebody in a car park and video themselves beating somebody up.

We wanted to create the idea of the 'Grandma Recipe' as a new kind of mass documentary clip and through this project catalyse that happening. All we've done here is give form to an idea – it's not a radical idea – you might video your Grandmother cooking her speciality recipe but we've given form to it and we are asking people to submit their own Grandma's through whatscookinggrandma.net and really we are trying build something that capitalises on people's desire to put a bit of themselves out there. We were debating earlier whether that is a new phenomenon that people wanted to share and make their lives more public or whether it is something old. That's what we've done.



www.whatscookinggrandma.net

MC: It is really difficult to gauge if these people are doing it because they can or because everybody wants to put themselves out on show – some people make music, some people make other things but now you can actually distribute it more widely. So something happens now – and why and what exactly is another problem. So this [slide] is Nannie Webb this is our Grandma 00 – the first submission to the website so appropriately named Nannie Webb we will carry on promoting this, we will exhibit it in other places, we will use and are already using radio, newspapers, the web, TV to expand this. So from this idea and this three page website we are going to create something that will have the platform and the ability to grow a lot bigger. Together with that we also work on other products and services and other things that can exist just as messages or as actual commercial things. We like them to stay as messages because then they remain in the ownership of the people. So these [slide] for example are in the show at CityLab and this is a Grandma Player – your Grandma can record herself cooking something that you particularly like, close the jar, give it to you and then in turn you can play it back on your kitchen top and do exactly what she says. So that is one more chance to get it right.

The Grandma Player

CV: This is an audio only player of your Grandma – and if you go to the show you will be able to hear it. It is Sonia who you saw earlier cooking Lancashire Hot Pot cooking her Leek and Potato Soup.

MC: So besides that we have services as well such as 'Rent a Grandma' you can ask your Grandma to come to your house and show you how to do it. We have things like 'Put Grandma in the Menu at a Restaurant' so that would be a chef that takes on a recipe from Nannie Webb down the road who can do this particular thing really well and anybody who comes to the restaurant can have that.
CV: So just to finish off, what we are trying to do is stimulate people to start contributing to this website through YouTube™ and then we're going to take the content from this and try and build new products, services, emotions, ideas around that. That is where you can submit your Soda Bread or Apple Crumble we'd love to see your videos up there and you can see more of our fictional products and other work online.

9.7 Discussion

From the floor: I have a question for Human Beans. How do you think it changes from you doing Grandma's to other people videoing their own Grandma's and how does that affect what you are trying to do with the project?

Chris Vanstone: The stuff where people video their own Grandma's you can see actually how much richer it is. Really the only reason that we videoed Grandma's was that we felt we needed to create some content to catalyse the stuff happening and we thought that was the best way to do it. If you look at Nannie Webb [http://www.whatscookinggrandma.net/] it's charming because there is years of interaction there and you know what the best stories are. Eventually we will put a video up of Mick's Grandma cooking her speciality which translates as 'Donkey's Ears' – that is a really sweet video. How is it going to change? Well, hopefully it's going to get better because we won't be doing it.

Keith Brown: This question is for Lionel - you said that you were having a conversation with a client who had actually seen your product and you hadn't

and it wasn't quite the same thing. I've had RPs [rapid prototype parts] made that I've never seen that have been in exhibitions. There is something that is not quite the same between the CAD [Computer Aided Design] and the actual object when it is output. I just wondered if you could say a little bit about what was it that wasn't quite the same maybe? It's a difficult thing to try to…

Lionel T. Dean: Scale is a large thing. You know how big this thing is on screen and you can measure it but it's not quite the same thing as having it there in your hands. Being able to just tumble this thing around is not the same thing as having to use some device to tumble it on screen. There is something that is much more direct or intuitive when you are actually holding these things in your hands. Generally what I miss is the presence in the space. I have a studio in my home and I habitually wander in there before bed and check things out and you see it in a different light than when you are working with it through the day. If you just wander in there when you haven't been working on it and just look in the door you see it in a slightly different way…

Keith Brown: With a generative system like that which will output possibly within a particular kind of set parameters do you find other things that are going on that are possibly surprising, you don't expect or whatever that a potential end user, consumer might choose? Most of the time my experience is that I am delighted with the output when I do see it but on occasions I am disappointed because it is not quite what I thought it might be. Is there any way of compensating for that within the software design maybe that is going to generate these possibilities?

Lionel T. Dean: I think it is one of the compromises with having a generative system is there are ones that I won't be one hundred percent happy with. What I would like to do is generate hundreds and pick my top ten all the time. But that is something that I just have to step back and let go and say *"No you set the rules if it meets the rules it should be good enough"*. That is what you have said and they always won't be your favourite one. That is something I have to come to terms with and I'm not always comfortable with.

Keith Brown: It is just such a shame it is such expensive stuff – well it is getting cheaper but not quite affordable enough to do that.

Lionel T. Dean: It is getting a lot cheaper the printing systems are getting a lot cheaper – I remember when you couldn't afford a desktop system – it is going to happen very quickly.

Keith Brown: Thanks.

Tavs Jørgensen: I've got a question for Human Beans again is there an element of some information is best forgotten? [laughs] Some of the recipes could carry a health warning. Another thing – I can't remember who said it – the most important ability of the human brain is the ability to forget otherwise we would be scrambled. Is there some of this information – the recipes – that is best left to the past? In the information age we have so much information we are trying to record everything – we are recording this today – some of the information is best forgotten.

Mickael Charbonnel: Yes, I suppose your question goes two ways. We had discussions with these Grandmas and they had other recipes and some of them I wouldn't have tried [laughs] and sometimes some of them are very unhealthy. So yes, those are probably best forgotten. I think the second thing is about information and how much we can submit ourselves to. It is a matter of choice really and this is exactly what is happening. I don't see my Grandmother that often and I don't really miss it but I know that when I spend some time with her I do connect with something and I do enjoy it. Now whether I will remember that recipe or not, that we cooked together is a different thing. But if you take the recipes as almost a pretext then you have a good reason for taking on this information.

Paul Rodgers: I think what is great if you look at Gordon Ramsay that is in these programmes like "Hell's Kitchen" and you get these people that put themselves up against him – like your Granny's scone recipe…

Chris Vanstone: He wouldn't stand a chance against Jackie [laughs].

Paul Rodgers: Well, he wouldn't. I would imagine that Sonia's Lancashire Hot Pot would beat his. It is a bit sad that people will go and do Ramsay's Hot Pot as opposed to someone who is more aptly – it has been passed down and down and down – and got roots in real Lancashire Hot Pot as opposed to 'virtual Ramsay'…

Chris Vanstone: Then it's about amateurism, I guess. It probably is as good if you think it is as good as Gordon Ramsay. I guess Gordon is putting it against the best Hot Pot ever but that is not what everybody wants – the best ever. They want something that tastes like how they like.

From the floor: It's about nostalgia. People on the Ramsay programme do not taste *"is it good food?"* They are tasting *"does it taste like what I know Shepherd's Pie tastes like?"*

Mickael Charbonnel: It is quite funny because when you start looking at – we did about six Grandmas already and when you have been watching it you realise that actually they do it in their own way and even the traditional Lancashire Hot Pot – although Sonia tried to make it in the most traditional way she could it still is her own way to do it. So I don't chop onions like that but fifty years ago they probably didn't chop onions like that either and I have no idea how they would because I'm not from here anyway so I've never seen it. So, nostalgia goes out the window I've got no links with that. Maybe the only element is that I miss my Grandma from when I was a kid.

John Marshall: I think that is a really good metaphor for something that is running throughout all the presentations. A lot of people have been saying "I'm not an expert, or I haven't invented this technology – I'm not a NASA scientist" and almost apologising for that. I think you are all using technology – as Aoife said, not for technology's sake but in order to reach some other end and you all have your own 'recipes'.

Mickael Charbonnel: More as an enabling thing and it doesn't really matter what the technology will be as long as there is a good ground for something to happen.

Justin Marshall: I think it is important that you remember that there is quite a lot of people with backgrounds of making here that technology might be a tool but it is a tool that effects what you do. I'm very conscious of when I'm doing things that it is having an impact on what the actual result is. It is not "I have a goal and I will then reach it." Maybe that is the craftsperson or the sculptor in me rather than other methods – I'm not suggesting it is the only way of thinking about it but it is definitely the way I think about it. It's quite easy to forget that sometimes because - it doesn't become transparent – but you can forget that you are engaging with things in a particular way. When you meet people that are not using that technology I think it becomes much more prevalent – you suddenly recognise what it is in your practice that is different – not your practice just about the way you think that is different than other makers dealing with similar issues maybe.

John Marshall: Can I just ask you on background – how do you feel about being on this panel with these other people – coming in contact with other people, other makers with very different practices?

Justin Marshall: Obviously, its incredibly interesting to be anywhere where you can see a whole range of approaches but what is amazing about this exhibition is it's diversity and it is not centred in – there has been other exhibitions about digital technology but that aren't just about exploring potentials of making things and it has a sort of craft bias, or it has a sculptural bias and it sort of seems to cross many more boundaries. So it is much more difficult to situate yourself easily but at the same time it is much more exciting in terms of how you can consider the issues of the boundaries and perimeters. I wouldn't have imagined some of the things I saw here until I came here today and how they fit in with that blurring or the agenda that you and whoever was involved in the curation of the show had. It's quite interesting to see how Human Beans fit into the blurring between architecture, design and sculpture for instance.

Paul Rodgers: I think this is a typical thing in Britain. When I was interviewing (particularly) Dutch designers in their studios and asking what they were doing next a lot of them were taking on pretty sort of big art projects –

sort of urban scape art projects. I was asking questions like *"There is a lot of risk there - it could fail or damage your reputation as a designer"* and they didn't see any distinction between design, art and architecture. They see it as something bigger or that is not such an issue – they commented on that quite a lot – I think in Britain (ok, I think it is changing) but people still see themselves as designer, or architect or artist. Someone like [Thomas] Heatherwick doesn't want to be labelled by anything – I think he's on the other side of the coin. I think he's very protective of what he is.

Aoife Ludlow: Someone asked me five or six months ago was I an artist, a craftsperson or a designer and I kind of looked at her. I don't know how to answer that question anymore and I wouldn't even - from a textiles background there are textile designers and there are people who use textiles that are craftspeople – I always feel I'm between the two anyway. I still don't know what I'd answer to be quite honest.

Paul Rodgers: For many designers the "Craft" word is almost as bad as the other "C" word.

Aoife Ludlow: For many craftspeople it is as well, they don't want to be called craftspeople they want to be called designer-makers.

Keith Brown: A question for Lionel and Justin – I've always thought of a tool as something that is used skilfully towards a known end – that might be some sort of loose definition of what a craft is. I think the way that Lionel is using the technology I see that as more of a medium than a tool although you use tools, but it becomes a medium and not just a tool. You are exploring possibilities within it towards unknown ends a lot of the time.

Lionel T. Dean: Yes. You are using tools that the rules are going to work with but yes you've got these rules that are above the tools and yes they are much more of a medium.

Keith Brown: It somehow transcends that in a way, certainly for me when I'm using it anyway. The unexpected surprises that come out that you don't

somehow skilfully produce them they come about through your practice through using the technology.

Lionel T. Dean: I think you do but you can't visualise that at the beginning. One huge thing that this is throwing up for me is that in the traditional design process you visualise the design to start off with and you do a concept sketch and you sell the design on the concept sketch. Now you go into a client with some doodles and some calculations and it's just not sexy. So it is trying to convey that to a backer whoever that might be whether it is an exhibition or a client or whatever. It is trying to convey what you can potentially do without having done a part of it already because there is no short cut to it. You can't rattle off a little bit. With the generative stuff it goes in the reverse way round – traditionally you'd start with these wacky concept sketches and it gets slowly a little bit toned down and quite often the output is quite ordinary. Whereas this goes the opposite way round and you start off with some quite mundane, simple relationships and slowly builds the complexity up and ends up with something as you say that is very unexpected.

Justin Marshall: I wasn't using the word 'tool' in a very functional manner I did think about tools as a much broader thing. I was trying to get over the point that I don't think it is a simple, functional way of getting from one thing to another. I do recognise it as I suppose you could call it a medium in which things change or you think about changes. It is a much more iterative process using technologies than simply *"here's the end point and I'm going to get there using this hammer, computer, whatever."* Yes, I'd agree with you in terms that its impact is beyond the simply functional.

Tavs Jørgensen: We probably need new terms to describe the many conduits – technology is breaking down the barriers between traditional practices and maybe also breaking down the traditional concept of what is a tool, what is a medium. We need new terms for what we are doing and the categories that people inevitably want to place things in.

From the floor: I think 'tools' is the term to use if you recognise that every task is changed by the tool that you are using. So the task that you've all

described – the tools that you are using change the nature of what you are doing. I think I would agree that Lionel's use of the tool is something a bit further and your intention is then shaped by the use. They are tools but the nature of what you are doing is shaped by your choice in the use of that tool.

Robb Mitchell: I wanted to ask, this is mainly for the potter – is it Tavs?

Tavs Jørgensen: Yes.

Robb Mitchell: When you are developing these techniques how focused are you on thinking about the particular piece that you are going to make that day or that week, using this new technique or how much are you thinking I'm going to develop a technique and then other people might use my technique and then go on to make more things? And if it is the second, then how much effort do you put into or what is the best way to share these techniques? Is there a YouTube™ for computer aided ceramics?

Tavs Jørgensen: Well I do a lot of talks and presentations and I tend to be very open with the methods. They are incredibly simple – the methods – I could get my four year old daughter to move the MicroScribe® around and do that. That is also part of the attraction of new technologies that you do share – I think that is important. That is the way that research and knowledge works – you are standing on shoulders. In research departments you do get points and funding according to how much you disseminate that research. You learn a lot by sharing information. I do think you have to make the process available but I do enjoy these pieces I don't mind making excuses for making things that are beautiful.

Julian Malins: How important is it that at some point or other (perhaps as undergraduates) that you learned skills as makers – I see it as a bit of a paradox going on between the need to learn about materials and that sort of thing and at the same time these technologies really allowing you to do things without ever touching material. But it seems to me that you all have strong sensitivity to volume and form and everything else which must have come I think from actually handling materials at some point or other. So you still need those kind

of basic skills and at the same time you need these advanced skills if you like moving on to use the technology in other ways - is there a bit of a paradox here?

Tavs Jørgensen: There is – and that also comes back a bit into what Human Beans were saying that skills will become redundant. And I think there is a value in terms of forgetting skills and finding new ways of doing things – I think material knowledge is particularly important – knowing the qualities of what glass does when it is heated up or what clay does.

Julian Malins: Can I ask what the future of education is? Where do you see it?

Mickael Charbonnel: I think that ties up with something I wanted to say earlier on about what we were discussing. When you actually create these tools that you guys create where there is quite an element of randomness - you establish rules - it is a bit like when the first synthesisers were created: you pressed a button and you wouldn't really know what would come out. But the thing is that through that particular complexity you actually develop a certain sensitivity and then you develop a skill and then you develop some instinct and then off the back of that you end up creating something that in terms of skills and sensitivity and understanding of that process is as valuable as handling something physical, I think. It is a matter of developing these techniques or tools or processes or mediums whatever we want to call them enough so that others can share them and in turn teach it and make it something that can be exploited.

Tavs Jørgensen: But I want to add to what I've said that none of what I have done here I wouldn't be able to do it if I didn't have grounding in material knowledge. My skills with 3D software is - I think going back to what John is saying - is really quite limited. What I am bringing to the table is my background as a maker and using the technology in that context.

Aoife Ludlow: I'd have to agree with that I think you can't lose sight of the importance of the material skills and the handling and forming and setting well in textiles – there are so many craft elements and there are so many basic things

about the make up of the cloth that you need to know before you can know how it will behave. I think you need to be taught that but then you need the freedom then as you progress to maybe go and work in a different department the freedom to move from that but I think you are missing out of a huge amount if you jump straight to computer based design. Digital printing is actually prevalent at the moment in textiles - they take a photograph, they mirror repeat it and they print it out and there is something really soulless and there is something really missing in that process.

Justin Marshall: I think what Julian was asking about the future I find it quite difficult to measure the time none of these things are quick – I'm maybe just a bit slow but it takes me a long time to learn things. Especially, there is a lot of computer stuff that it has taken me a long time to get to not a superb level but a level in which I feel I can use certain things usefully to do interesting projects maybe. But also it takes a long time to use clay and what can you fit into a BA or even a BA and MA. There is a limited amount of time and actually it is very difficult to imagine how you can get to - I mean, Tavs I know has had a particular education based on some very definite grounding in traditional skills and then some art school and English training – it takes a ridiculous amount of time to get to a point where it becomes useful. So I don't know how you construct courses to fit it all in, basically. I don't know. As for the future of courses, you could pretend that you could do a BA in ceramics and digital technology but actually what skill level people would get to?

From the floor: Maybe we should have an apprenticeship system or something like that – intensive training in craft skills alongside the digital?

Justin Marshall: I think there is an element of how much you can pack into a traditional degree structure so I don't know the answer.

From the floor: I think there is also a concern that there are less students interested in the crafts – certainly in ceramics there are a lot less students going in to it. If you need that underpinning how is it going to effect people that come in, students that go to art school and just embrace technology from the word go?

Lionel T. Dean: I think that you also have pressures from institutions because are resource-hungry in terms of workshops.

Keith Brown: Do you think it could also be liberating maybe for people that don't have those sorts of craft skills? I'm dyslexic I can't spell my name longhand but I appear in academic journals because I've got [Microsoft] Word. It's not that I don't have ideas I have got something to say but I just didn't have the skills to do it until the word processor came along. I'm wondering if that might also apply to these new technologies and making, or producing? I happen to have a traditional background I happen to have been making sculpture for forty years so it is difficult for me to answer that question as a maker because I've got that. I'm pretty sure that this must be an absolutely liberating technology to enable people to do things that they otherwise wouldn't be able to. Have you any thoughts on that at all?

Lionel T. Dean: All of us have come to this from starting off with a grounding in traditional skills and moved into the digital side. I think we'll only know in the future when people have maybe just purely gone digital.

Chris Vanstone: I think just in terms of home movie making just making software that is easier to use as well as the cost of the technology dropping enables people to make films that wouldn't have been able to make films before. I think a lot of the roots of the skills we've picked up are because of using consumer software and moving on through that rather than any real training in it.

Julian Malins: Now you've got people who are just doing it themselves: DIY - so in the future the equivalent of that then would be people making everything themselves you'll be able to mock up your own crockery and furniture and into a microwave-like 3D printer. It would be an interesting world.

Chris Vanstone: I don't think the fact that people are making their home videos means that they have stopped watching feature films I think it means they probably watch them more intently.

From the floor: I'm just wondering as an integration of technology in a craft discipline – a question to Tavs, have you ever considered using the glove in traditional craft? I know it would get a bit dirty throwing a pot with the glove on, but you could throw the pot and record the throwing action and see what that maps out.

Tavs Jørgensen: That's not really my interest. My interest is in extending... I can already throw a pot it's not a problem if I want to make a pot I can throw it just like that. I want to extend the possibilities of my making beyond what I can already do with physical material. There is no material available for me to do this with my hand and define an edge.

From the floor: Maybe a new vocabulary of form would emerge out of taking traditional processes: a saw, a chisel, a hammer mapping it and seeing what that meant?

Tavs Jørgensen: It is not what I am interested in. It would give a static representation of a motion and that is quite a distance from what I am trying to do.

Paul Rodgers: I think Robb raised a really interesting point actually. I think the thing I am asking because I wandered round [the show] this morning and everything is really exciting and I was really intrigued by the approaches that people are taking. But what I am thinking about is almost sort of a kiddie's question of "What is the point?" The questions we ask our students are what market are you operating in? What is the contextual framework? Is it critical, or is it commercial or is it a bit of both? So I know Robb started that by [asking] is it the process that is important or is it the outcome? I'm sort of thinking there is a couple of sets of chairs in the exhibition there is yours Lionel and yours Tavs. I think the little recipes in a jar are great products – they are sort of the kind of thing you'd see on 'Dragon's Den' being really successful. I'd love to buy one I think there is massive commercial possibilities in it. But in terms of the two sets of chairs what is the market, what is the contextual framework, what sort of boundaries are you setting for yourself at the outset? Is it to explore the process or is it a real critical or commercial proposition?

Lionel T. Dean: It is not a commercial proposition. It is a chance to escape – from a research project I wandered into the commercial realm with the projects for Materialise and Entropia because you've got to make some money somewhere to fund your activities. With the chairs it was a chance to do something that was more personal and a chance to create a beautiful object.

Tavs Jørgensen: Until very recently I made my living from my professional practice. It is an interest – you have to keep your professional practice going by feeding it somewhat. Things feed down from my research into the commercial area. Superficially, you take certain aesthetics of what you develop and apply that in a design or in your craft practice.

Cezanne Charles: I have a question for Human Beans. One of the things that is great about cookbooks is that you can annotate them. So you have your Grandmother's cookbook and in it you can write "It needs a bit more salt." Would you be happy if someone remixed the videos on YouTube™ and sort of spliced them together?

Chris Vanstone: [Laughing] That would be brilliant. Wow. So you take the best from each Hot Pot and you make a... yeah. Sure. Do it. That sounds great.

Mickael Charbonnel: You can even make new recipes out of a few different ones.

Chris Vanstone: Or a complete three course meal.

Mickael Charbonnel: You can comment on YouTube™ you can say what you want about the recipes and perhaps perfect them that way. Say "I looked at the video and put as much salt as she did but mine is too salty."
Chris Vanstone: But remixing – that's good. Free ideas. Brilliant. More free ideas.

Julian Malins: You know you are almost going from not just different products to services the idea of a customer having their say in the whole thing as

well. So it's not just changing the boundary between what is a service and what is a product but shifting the relationship with the customer.

Tavs Jørgensen: I would agree with that. I think it can democratise in some way you are with YouTube™. You are giving up the ability for everyone to create. I think that is what is really exciting about new technology. You talk about the fact that a camera is very cheap and with 3D modelling packages there are lots of free ones. All of a sudden you can…

Mickael Charbonnel: I think what is also quite interesting at the back of that is that very quickly… YouTube™ is a platform where you can have the worst like the best. But somehow it is dragging it towards either the funniest or the most entertaining towards actually trying to do better than the others. The risk with having enabling technology like that is that in the future I might be able to print my own sofa but it might look utterly horrible because I might be really bad at it. I could pick someone else's design who has been trying to do better than everybody else and get a decent quality shape or sofa or design. So I think the good thing in this is the central interaction between people who are willing to make these things and willing to show them as well to others.

Aoife Ludlow: It is the Shareware ethos in a designer.

Justin Marshall: Isn't your FutureFactories project – I know a little bit now about the software you have used – you could have made it hugely interactive if you chose to but you made a conscious decision where to draw the line.

Lionel T. Dean: There was a lot of discussion about should we have slider bars so people can adjust 'parameter x' to their liking. But I decided that was not the way I wanted to go with it. This was going to be mass individualisation rather than customisation. There is plenty of merit in mass customisation it is just not what I want to do.

Aoife Ludlow: I think something that is really important is the idea of design as something that is inspirational in the marketplace especially with people aspire to own things, people aspire to have their own creations… they aspire to

have that thing that has been put there as the best. I just don't see people wanting to make their own chairs.

Paul Rodgers: It is the cult of the celebrity – 'Design Idol'. Look how many people watch 'Pop idol' on a Saturday.

Robb Mitchell: But look at how many people still do Karaoke. As far as I am concerned on YouTube™ a lot of the most popular and successful things are not necessarily the worst quality but they are of questionable taste.

Chris Vanstone: I think people are going to be too busy filming their Grandma's to print their sofas.

John Marshall: On the schedule, I was supposed to summarise all of this but to be honest you've covered almost everything I had written down. We're looking at the sea of information we are surrounded by and how that becomes physically manifest through processes and through practice in some form. How this information becomes tangible through the interaction of objects and the relationships we have with objects is something that this show grew out of. We wanted to bring disparate practitioners from communities that don't normally have this kind of discourse together. There is an all pervasive technology but it seems ghettoised so we wanted to try and address what lies on the perimeters, boundaries and borders between disciplines that are using common technologies. I think this has been a really valuable discussion and I would certainly welcome more inter-, multi-, trans-disciplinary forums like this.

10.0 Appendix II: Practitioner 1 interview

1. Where did you see the call for PBB?

I got it from an internet search because I periodically search for things which are relevant to digital media, so it came up through that.

2. Why did you apply for PBB?

It seemed to be absolutely my area – the description of the exhibition is exactly what I'm doing and it's the opportunity to create great new stuff, which is always the issue in the area that I'm working in is that there needs to be a reason to make something, so that was ideal.

3. What about the brief made you think your work was appropriate?

All I can remember is that I was absolutely; "God I should be doing this". Pleased that I stumbled across it.

4. What did you expect to get out of the exhibition?

The opportunity to make whatever it was I was going to make and then PR associated with that.

5. Who did you expect to be in the exhibition?

I guess it was a chance to find out who was doing what locally. I don't think I was thinking of this particular figure or that particular figure.

6. Was there someone you expected to be in the exhibition that wasn't?

Well, you don't know who's been invited that didn't turn up, but I guess it would be guys like Patrick Jouin, Freedom of Creation…these are just my particular area.

7. Was there anyone in the exhibition you were surprised by?

[Long pause] No. There were ones that I appreciated more than others, but I guess…it's hard to say. The most entertaining one from the seminar was the Grandma Soup [Human Beans] one. I don't think it was particularly relevant to the exhibition, but I was entertained by them, so as a visitor I would have been

entertained by them. If one stood out as different and maybe a non-sequitor to the rest of it, it would have been that one.

8. Did the exhibition live up to your expectations?

The venue, the exhibition itself? Yes. I was expecting more of a gallery, but I think the most was made of the space that was there - it was fine, yes.

9. Were you happy with the way your work was displayed?

Yes, pretty much. Then again, you come down to this notion we have of an idealistic gallery space, which it wasn't, but again I think a lot was done with the lighting, so yes.

10. What could have been done better?

Yeah. I think if we could have had gone in and looked at the space sooner, maybe, and thought about the projection, which was an issue, we sorted it out with the fringes by masking off a little bit. In preparation on-site we could have done that a bit better maybe, but I don't think it was that bad.

11. In your opinion, what was the strongest work in the exhibition and why?

That's such a difficult question. I can't say there was one…there were areas where it was strong… in terms of visual impact and the impression it left on you I'd have to say Justin's because of the scale of that wall ['Penrose Strapping 1'], but I had a lot of problems with that as a piece of work. So in terms of 'do I think it's the strongest work?' I don't, but I do think as a piece of it left a strong impression on you. I think there were other pieces that were much stronger than that. The light ['Warp'] was very good, but it's a little bit of a one-trick pony. Its' a case of; 'ok, got that now'.

Geoffrey's is strong but I appreciate him a lot more now that I did at the exhibition, partly because you go to the exhibition and you're thrashing about trying to put your things up, and I have a lot more time to consider it now, so don't think I got the most out of that. I love the little automaton ['Chicken Soup From Mars'], the little creatures with the… it's probably, that's a simple one but it think that was one of the strongest pieces.

12. In your opinion, what was the weakest work in the exhibition and why?

Same person I picked for the strongest but one that was on the floor ['Morse']. I don't think it worked on any level – it didn't work on a pure letter form. It had to be explained. It didn't meet the brief, I didn't feel, that particular piece.

13. Were you surprised by any work in the show? Why?

Surprise is a difficult word. I'd have to say no. In terms of "Wow, I'd never have thought of that". There were things that intrigued me. like the weather mapping ['Cyclone.soc'], it's a clever idea which would never have occurred to me . There were other things that would have merited the word surprise, but it didn't surprise me because of the field in which I'm working.

14. Did you think the exhibition was coherent?

With the exception of the Grandmas [Human Beans], yes I do. I think it was quite disparate in terms of what people were doing, but I do think it hung together. That's the only one that I thought didn't quite fit in.

15. How would you sum up the core theme of the exhibition?

The interface between digital technology, craft and design and the three things coming together and the fringes of all three. Is how I would interpret it. When I explain to people where this chair is that's what it's about, it's exactly that.

16. What did you most like about the total exhibition?

The way the space worked out in the end with the windows. The way we had little rooms and windows into other people's little rooms so that kind of worked for me. Yes, I've done that twice now. Best piece/worst piece and the space I'm contradicting myself as I go long… [laughs]

17. What did you least like about the total exhibition?

I guess the location. Lancaster.

18. Many visitors to the exhibition would have liked to have seen more technical information – what do you think?

I really wonder whether they WOULD want to see that. At the expense of what? Or are they saying they'd want something additional? Are you presenting this as stand-alone exhibits or some kind of tutorial? I think that's the issue. Is there a balance to be had? I guess, in hindsight if people are saying that then it should be addressed, but I wouldn't have thought that'd be the case to a huge extent I just think that *some* more information. A little bit of background. Or maybe it could be something you could opt into if you want it, but to have it in everyone's face might spoil the magic. Also, if everyone was doing rapid prototyping then you'd have little one explanation and if I felt people wanted to see more I'd put it on the video.

19. Have you made any new professional contacts because of this exhibition?

Yes, the guy with the book; 'Designers on Design'. Paul Rodgers. The timing in terms of the exhibition itself, I was just there for a private viewing and that was all, so maybe I didn't see as many people as I could have.

20. Have you received any new opportunities because of this exhibition?

Not that I know of, but I don't know because the whole thing is elevating a profile and people come at you through the website, you never know which exhibition they know you from.

21. Has there been any impact on traffic to your website because of the exhibition?

Yes, it went up quite a lot, but unfortunately we shot ourselves in the foot. In mid-October we updated the website and the traffic zoomed up but we lost our contact page. We're now at 50-a-day, average. We were at 25. It has doubled, but it's hard to substantiate why – there's the show and the updated website. It's not just one source.

22. Has being in the exhibition had any effect on your work?

Yes, because I've moved onto a different scale, something a lot larger than I had before, different lighting that I had never done before, we've got the real-time cracked; finally done it in real time instead of fudging the issue and doing a

looped animation and implying that it was, we've done a real-time one. Which, I know didn't go down particularly well necessarily, but I feel really satisfied about. It's a step forward, you can press and button and it's different every time.

23. Has being in the exhibition had any effect on your thinking about creative disciplines?

I'm incredibly insular and don't really examine things in such great detail – I'm too wrapped up in what I'm doing. Yes, I guess it has in a way. It's very close to what I'm doing, but from a craft discipline side, say like Tavs for example. Those are the ones that made me question, the things that are quite similar in a parallel way.

[In what way? Use of technology?]

Yes, it's the use of technology, the way it is applied, the fresh thinking, the innovative ideas…anything like that makes you question what you're doing almost like; "I wish I'd thought of that". Just makes me think more about what I'm doing in the opposite position; would I be thinking the same thing about what I'm doing?

24. Would you be interested in being in another show of this kind?

Yes definitely.

25. Would you be interested in future opportunities with Fast-uk?

Yes definitely.

26. When did you first make use of computer technologies in your work?

That's tricky because I've been using computer technology as CAD since desktop technology became available, actually before that because we were using university mainframes, so…'70s.

27. What formal training have you have had with computer technologies?

2D CAD which I regard as a different discipline. It's like drafting, it's not CAD as we know it today. 3D CAD I'm self taught.

28. How would you describe how you make use of computer technologies in your practice (e.g. concept development, design-to-order, fabrication, pre-visualisation, prototyping, etc?)

As a tool from concept development on, you used to think that I'll do concept sketches then translate them, but no; from concept onwards now it's all computer-based. So, the concept from a mere doodle, that doodle will go to geometry to evolve the form.

29. How have computer technologies had an impact on your practice?

It defines the practice, basically. I define my work now as being focussed on design for digital manufacture. I don't do anything that isn't direct digital manufacture.

30. What (for you) is the key benefit of using these technologies?

Two days of discussion on the keys benefits of creative forms that I couldn't even hold in my head… to create these concepts, let alone produce.

31. What (for you) is the key limitation of using these technologies?

Two things - visualisation and mainly the expense of producing. Access of technologies in terms of production.

32. What is most important to you the finished object or how it was made?

The finished object because I feel that the virtual design isn't worth anything without seeing the reality, so it has no value without that. Although the bulk of the work is in the virtual object and that's where the intellectual property and the creativity lies, it is the physical embodiment that is the design and without that it doesn't exist. Absolutely, yes…but then it wouldn't be the scripting and model-making, it would be the appearance of that virtual object on the screen would be the design.

33. What do you consider constitutes 'sophistication' in the use of these technologies?

Whoa. Well it's not enough just to do something new to use the technology; you have to use it well. So we're talking about a range of different technologies, so all I can do is talk about the one I know. You can't just model anything. I've held my nose with a few questions/answers these past few days, because the idea that you can get into a modelling package and press a button, then say; "Ooh, look what's turned up!" that's just abhorrent to me. It's a bit like me walking into the clay workshop, picking something out of the scrap-bin, sticking a tool in it and saying; "Marvellous, I've never seen that shape before!" I think it comes with the naivety and it will be eradicated when more people are doing it, when these tools aren't freakish and new and you'll have to use them in a more clever way. You have to use the tools with some consideration, some reflection and some knowledge. You have to educate yourself in the tools. It's a bit like the argument of stunt rider or a horse in a Western – you have to learn to ride well before you can fall off.

34. What does the term '3D computer technologies' mean to you?

Well, exactly that. The only thing that's computer based/object based rather than text or audio based.

35. Name up to 5 practitioners that you would identify as exemplary users of 3D computer technologies.

Ok. From my field – Freedom of Creation, Patrick Jouin, Bathsheba Grossman, don't like them but I have to include them – the guys who do the pepper grinder. Austrians. I can't remember [Fluidforms]. I'm stuck for my fifth. That's purely because I'm going for my particular area.

36. In terms of discipline where do you do you locate your practice?

I see it on the design/art fringe. Some pieces that I do that are art, some pieces that I do that are design and some that are going to be straight on the boundary of the two somewhere.

[Engineer. Is that something you still hold onto?]

Yes. There's a technical element to what I do that is essentially engineering.

37. How would you identify the community of practice or discipline that you most closely relate to?

Design I guess would be the one that's closest. There are a few that might be called art pieces, but it's still a piece of design more than art. I wouldn't do something that's purely sculpture, there would be some function there even if it wasn't its primary objective so design.

38. How would you define the relationship between your work and its audience?

I never really think of selling anything. I don't think of myself as a designer/maker. The people who buy it would be buying it from a third party. I see them as an audience and I want to amuse and interest this audience and I want them to want the stuff, or at least appreciate it in some way. I see them as an audience. I guess I'd hope they'd be consumers and buyers, but I don't see them in those terms - as punters to do X, Y and Z.

It's in a magazine or a gallery. A magazine primarily, I guess. It depends on the piece and the future of the technology. It's unrealistic to expect everyone to own it at the moment because of the way the technology is. In the past, pre-digital times I designed things which were affordable, so I don't see why that can't be the case again.

39. Do you think there is a trend towards an emerging, hybrid discipline?

40. If so, what role if any does technology play in this?

Yes, I think there are definite opportunities there. The fact that there's a commonality and we're all working in similar ways…if we all move to digital production and we are all exchanging files…well, I was making a fatuous remark earlier really when I was saying well "does this make me a ceramicist." Well in the same way that I'm here on a weekend which is primarily about ceramics and I could easily produce things in ceramics. Now I couldn't if we were working conventionally. The idea that I could produce some whacky shapes, but walking into the clay shop and saying; "I'm a ceramicist now" would be absolutely ridiculous. Whereas the idea that I could produce a shape and manufacture it

digitally and have someone mould it for me and I wouldn't have to touch the ceramics, yes definitely.

[Anything to add?]

In terms of PBB, I think it's so valuable that we have things like PBB because the public are very interested; they want to know about this technology. They hear things about it, but it's a question of seeing what can be done with it other than what they get through the consumer end of it, through the media we're bombarded with. To see what can be done on a fringe level, a cross-border level is kind of interesting. I think it'd be great for an exhibition to get to a more mainstream venue, which isn't putting down Lancaster in any way, but it's just a fact of life that sadly most attention is grouped around the metropolis, so that would be a bonus. More of it. More things like this would be wonderful.

11.0 Appendix III: Practitioner 2 interview

1. Where did you see the call for PBB?
On the email.

2. Why did you apply for PBB?
The exhibition fit exactly what I was doing at that time.

3. What about the brief made you think your work was appropriate?
Just reading the general idea of the exhibition. The combination of technology, art and design…that's exactly what I was doing, or at least what I thought I was doing… so reading it I thought 'that fits perfectly'.

4. What did you expect to get out of the exhibition?
I'd been working for quite a while as a professional designer, but I hadn't been working on individual things, it was always related to companies, so this is one of, if not the, first big object that I had come up with the brief myself and was very personal to me as an interest. To be able to exhibit this first piece of work was interesting for me to go through the process. I've done a lot of stuff before, but it never was just my name, or my vision which I had to represent.

5. Who did you expect to be in the exhibition?
6. Was there someone you expected to be in the exhibition that wasn't?
From the brief, not specifically, I just expected certain people to participate with similar interests. I didn't expect any one in particular. Just to meet people who did similar stuff or think about similar questions.

7. Was there anyone in the exhibition you were surprised by?
Not surprised, the range of the exhibition was wider than I thought, but that probably had to do with me looking at it from my point of view and I thought the fact that it was very wide was one of the good things about the exhibition. When I first looked at the other projects I didn't know where to position myself within this range. I didn't really feel it until I got to see all the work. In the beginning things like the Grandma project, it felt like it was quite far in terms of

innovation within technology, not in use but in technology. So at the exhibition I felt that it works together with all the other pieces. The range was wider than I thought.

8. Did the exhibition live up to your expectations?
Yes, I think so.

9. Were you happy with the way your work was displayed?
In the end yes, it could have been more appealing, related to how it was in London before, but that was the perfect architecture for the piece. The architecture as an office environment wasn't really giving too much possibilities, but all the pieces had to fight with that situation. Probably mine was one of the ones that had more difficulty, but when I walked through the exhibition in the end I was happy.

10. What could have been done better?
I didn't look at the rooms specifically to see what other room would have been better, but the room we were in, the windows were quite tricky to …they were too high, so I made all kinds of decisions in the room, but the one I was in was ok, but it could have been more precise. Going through the exhibitions, looking inside all the rooms, it worked. I don't know if there would have been a better room. It didn't really matter in the end.

11. In your opinion, what was the strongest work in the exhibition and why?
Difficult to pick one because I felt that the level was quite…the same. Objectively there wasn't one which really flashed out, which I thought was good for an exhibition like that. Just a personal…there was different single things abut single pieces that flashed out for me. The way the Wifi piece was using information to do something with it – that was very good quality of demonstrating something. I wasn't sure about the Wifi signal in general to use it for something like that, but the way everything was produced from that concept on was very good.

12. In your opinion, what was the weakest work in the exhibition and why?

I think all of them had qualities once you understood and there were pieces where understand the background, the piece itself didn't tell you too much about it. The Japanese piece, even the CD player – to really get something from the piece it took more than just walking through the exhibition, or even just using it. The same with the pieces that were generated by recording 3D movement - as pieces of furniture, it didn't really work for me from a designer's point of view and the idea behind it – converting that into reality, I didn't really understand from the pieces. I thought it could have been done more to the extreme showing the idea of what the pieces were about.

13. Were you surprised by any work in the show? Why?

A lot of things, but also details. To go back to the ideas from the recording 3D…I think within this process, combining new and old technology I thought was very clever. But a single piece…

[You've already said that there was nothing there which you weren't already aware of…]

It's not that I knew everything already, but technology-wise I don't think there was something which went a step ahead of what I had seen before or knew of. It was within a very 'today' kind of technology and using it for an exhibition for a very good level.

14. Did you think the exhibition was coherent?

Yes.

15. How would you sum up the core theme of the exhibition?

If I describe what the exhibition is about to other people, I say it's an exhibition about technology in art and design and as a whole thing the exhibition was very wide, but still within ring that would hold hem together.

16. What did you most like about the total exhibition?

It had a nice feeling about it. I don't know how to express this. Different colours, light, things that were lit by themselves …walking thorough, especially as it was an office building, it gave a very specific feeling to the exhibition and that worked very well.

17. What did you least like about the total exhibition?

Maybe it could have been less local in terms of location and audience. To put the same exhibition on in London would have been a different feel, a different audience and range of people, but those were the circumstances from the beginning and I feel that the energy behind something like this, the way it was put together was very good. It's not a bad thing as such, but it could have been wider in a different environment.

18. Many visitors to the exhibition would have liked to have seen more technical information – what do you think?

19. Have you made any new professional contacts because of this exhibition?

20. Have you received any new opportunities because of this exhibition?

Not so far. Although Mark mentioned working on something in about a year's time, but nothing else.

21. Has there been any impact on traffic to your website because of the exhibition?

There was more traffic on my website, but I had two other things linked to my website within the last two weeks, but there will be certain amount that I can relate to the exhibition.

22. Has being in the exhibition had any effect on your work?

Yes, definitely. I'm still quite young within what I'm doing as, as I explained before, this exhibition was my first as an individual so I'm sure it was quite influential in terms of doing it, working with professional people like you and meeting other artists who do the stuff that I do on a one-to-one level.

23. Has being in the exhibition had any effect on your thinking about creative disciplines?

Not specifically. It probably proved to me certain things that I've thought. I mean, it's a constant development in my head about how I see these disciplines anyway. There wasn't anything that added a major new dimension to it or that questioned things that I've always thought; it continued this process of finding out how things are and where I am within it.

24. Would you be interested in being in another show of this kind?

25. Would you be interested in future opportunities with Fast-uk?

Yes.

26. When did you first make use of computer technologies in your work?

I started working as an industrial design intern in 1992. That was the first time I used Photoshop, very early versions and from that point on I got very quickly into this substantial tool for opening wide product design.

27. What formal training have you have had with computer technologies?

Besides the very first training on how applications work, it's been learning by doing. I pick up things very quickly. I learn by manuals and from there I learned how software in general works. Then it's easy to switch between them.

28. How would you describe how you make use of computer technologies in your practice (e.g. concept development, design-to-order, fabrication, pre-visualisation, prototyping, etc?)

I probably use it more that I should! It's quite handy for me. One of the reasons to come to the Royal College is that doing things for yourself by hand is a substantial part of the course because of the amazing possibilities in the workshops. To combine both of these worlds, the piece I did for the exhibition as a good combination of things. Certain arts were on the computer, but the whole piece I built out of nothing cut it by hand and that process was quite nice. I'm sure I'll use more computer for specific things but I want to keep the range within purely handmade stuff.

29. How have computer technologies had an impact on your practice?

It's probably a new generation thing. Designers today they see shapes and objects from the CAD world or from the real world, rather than the model making world as they did before. I feel that I'm in between; I'm not new or old generation so I fit in both worlds. To use computers in that way is, to me, very substantial for how I define myself as a designer. The piece itself would not exist without these technologies, even if I started the exploration by bending wires by hand and casting shadows from things that I built myself, from that moment on I put them into the computer, they really have a personality and quality that is very precise.

30. What (for you) is the key benefit of using these technologies?

Freedom, in combination with rapid prototype or digital manufacturing machines, it's up to you what you're doing. There is not much limitation anymore in terms of shape or design. The complexity is the key benefit; you can deal with much more and still handle them as an individual without having a big development team behind something.

31. What (for you) is the key limitation of using these technologies?

Depends on what direction you look at it from. It can be an aesthetic limitation, you limit your thinking to what the tools do best or fastest or easiest…or what you understand, rather than what the shape should look like. I would say in most cases, it's not really bad because that's where it comes from. You can choose a different process to come up with design ideas.

32. What is most important to you the finished object or how it was made?

For me the computer has more to do with the design that with other parts of what I'm doing. The things I'm working on at the moment, technology-wise, are rather simple and general.

33. What do you consider constitutes 'sophistication' in the use of these technologies?

Very individual. You could show me two projects and I could make examples. There are certain cases, in computer-aided car design for example, you can really see where people who are using these tools really understand how the surface is going to look in reality. Obviously they work in clay afterwards to get the last problems solved. There is a certain complexity about how to get surfaces looking good. And good car design needs very high sophistication in knowing how to use these tools. Most tools, as far as I know, they don't offer this simplicity from the beginning; you really need to know how to get here. So more clean, more simple, more natural, to me, looks more sophisticated than something which obviously shows what you can do with the technology. Rather then using repetition just for the sake of it. You can pare this kind of quality down to very simple transitions from one point to anther, but you can see if someone really adds something or really know how to shape and define the transition. In the end there is not a major difference, but if look close and you know how to construct these details then you can see the result.

34. What does the term '3D computer technologies' mean to you?

The moment where things get into the third dimension on your screen that you add in Illustrator or Photoshop. Where there is a real third dimension defined in the application.

35. Name up to 5 practitioners that you would identify as exemplary users of 3D computer technologies.

American design agency like IDEO or Fitch – they all use these technologies with sophistication, they all know what they're doing very well, whether you like the design or not. Individuals? Ora Ito for instance, he has his direction when using the technologies he really uses them very well. Mark Newson has a different angle, he uses it for visualising his ideas and within product design I like how much energy he puts in to get his pieces to look as they do. Meanwhile, most successful, up to date designers use computer technology in some way. All of them in their portfolio have at least one project where the use of these technologies is very substantial and leads to very special results. Some people use them very often, but everyone uses it to some extent.

36. In terms of discipline where do you do you locate your practice?

I've just started to define myself as an individual designer, but I use the term 'designer', I'm not an artist in that sense. For me what's going to, probably [laughs], define me in the future is the blur between art and design where these disciplines mix. It's a really new field that is just about to be explored and hopefully I'll be one of the people who define what that is going to mean in the future. I am sure I'll be a designer in that field while others will come from the artistic side and maybe also do design, but still be an artist. I'm sure I'll be a designer getting closer to what is defined as art, but using my knowledge from a design background.

37. How would you identify the community of practice or discipline that you most closely relate to?

There isn't that much work yet. Within the next few years, if I can afford to, I'll try to stretch the area within different extremes. Hopefully I'll be able to cover a wide range of things and during that process there'll be a direction that is going to be more important to me than others. It's a bit too early for me to answer that question.

The new problems and possibilities that relate to globalisation, what's happening in the east in terms of production, how markets are falling apart more and more, or get so small because they are too fractured – I want to be part of what's happening right now, so my work will relate to these conditions.

38. How would you define the relationship between your work and its audience?

For now it's going to be both, clients, companies, individuals I can reach through galleries or my website and obviously, if you go through a company with a product it's the people buying it in the end.

39. Do you think there is a trend towards an emerging, hybrid discipline?

It's the whole range and it'll probably stay like that because while I'll be able to do more properly designed product, the inspiration I get from doing individual conceptual work, at the same time I'll be able to do bigger or even more

sophisticated individual work. As far as I can see from right now, it's the whole range of audience. Art and design.

40. If so, what role if any does technology play in this?

Technologies are a very substantial part of this because of the possibilities that you gain through the use of it. There are always going to be people using analogue cameras. Even if digital cameras are so much more sophisticated. It's the beauty of the simplicity. In design it'll be very similar; people doing things in non-technological way, but the main innovations are going to relate to what's possible or how people are able to use technology.

12.0 Appendix IV: Practitioner 3 interview

1. Where did you see the call for PBB?

Justin forwarded on an email sent to him.

2. Why did you apply for PBB?

It seemed to fit generally into the field that I work in for research and I think that was more or less it. I also liked the graphics on the call so visually it made me apply.

3. What about the brief made you think your work was appropriate?

The visual aspects of it obviously cornered the research that's going on, it seemed generally quite broad.

4. What did you expect to get out of the exhibition?

To be quite blunt about it I like to apply for exhibitions that my work fits into it gives my work some focus and a deadline to get work completed to.

5. Who did you expect to be in the exhibition?

Probably some of the usual suspects that work in this area. I would expect Geoff Mann to be there and he was there were a few surprises. The exhibition was much broader than I thought but the usual suspects - some were there and some were missing.

6. Was there someone you expected to be in the exhibition that wasn't?

Maybe a few from the craft scene Gordon Burnett might have been expected to have some pieces in and Ann Marie Shillito perhaps. It was good to see a bigger breadth than is normally seen at these exhibitions.

7. Was there anyone in the exhibition you were surprised by?

I can't remember all the names but I was surprised by how broad the exhibition was from very conceptual art to media based pieces.

8. Did the exhibition live up to your expectations?

It did, very much so it was well organised. folly was constantly in touch in terms of what they needed and by when. I never saw the exhibition completed because when I delivered the work it wasn't quite complete. I was delighted with how professional it had all been organised and put up.

9. Were you happy with the way your work was displayed?

I was happy with the way my work was displayed. There seemed to be attention to the lighting in particular I thought it was very good. [Programme Manager] was in touch about details which he didn't need to and he made a real effort with consulting with the exhibitors.

10. What could have been done better?

I think the venue was not ideal the rooms were obviously office rooms. This was a back up venue because I understand that the original venue fell through. I think that the venue was the main issue for me.

11. In your opinion, what was the strongest work in the exhibition and why?

It's very difficult for me to answer not having seen the full exhibition up and running. Visually the New Zealand guy [Brit Bunkley] with the sheep and the plane going over the sheep I think there was something of the representing of nature in there. Also Lionel Dean's ['Holy Ghost'] chairs I think the proximity of that piece next to the sheep and the plane. Those two pieces together probably, in my mind, visually were the strongest.

12. In your opinion, what was the weakest work in the exhibition and why?

'What's Cooking Grandma?' was very different work I found that less interesting I'm not sure that that needed a physical representation somehow.

13. Were you surprised by any work in the show? Why?

I was surprised by the breadth of the show I quite liked the 'Wifi Camera Obscura'. I thought that was one of the better pieces for me. I think it was the variety and the breadth of the show rather than picking a particular piece.

14. Did you think the exhibition was coherent?

Yes very much it seemed to illustrate the breadth of the use of visual medium within the arts without losing focus.

15. How would you sum up the core theme of the exhibition?

I will go with what I intuitively thought. I suppose it's the media effect on creative practice the possibility it provides with the physical object and the purely digital expressions and inventiveness and the variety which I think is a key.

16. What did you most like about the total exhibition?

It was interesting, it was engaging - something that you wanted to explore. It's rare that I go to an exhibition and really want to see everything. it made really curious what the next room contained.

17. What did you least like about the total exhibition?

The venue.

18. Many visitors to the exhibition would have liked to have seen more technical information – what do you think?

I think that would have been a good idea I think that a lot of this work can be quite dense for a visitor without any in-depth knowledge to grab onto, technical information like how did you do that, what did you work on? Stuff like what software programmes can be used - I think that could be a real starting point for many visitors. The tools that we use which are an important part of what the work finally becomes.

19. Have you made any new professional contacts because of this exhibition?

folly is an interesting outfit I have a provisional contact and you lot [Fast-uk] really but not so much with the other contributors.

20. Have you received any new opportunities because of this exhibition?

Not directly. The exhibition made me focus on a body of work and that body of work has since had a lot of press. The work that was made for the show has been in Icon magazine.

21. Has there been any impact on traffic to your website because of the exhibition?

I don't monitor it that closely I'm not sure.

22. Has being in the exhibition had any effect on your work?

I'm more aware of what other stuff goes on in the field of digital art. My work is located in the digital craftsmanship area. That field has been slightly insular in some ways for a number of years. There has been the same group of people. It was great just to get an idea of what goes on broadly in the field of digital-based art. It will probably have an effect later on. The exhibition brought together a number of communities that can be a little bit disparate even though they all work with digital as the core of our work. There is the media rich community and the craft-centred community and they tend not to mingle much and the exhibition achieved that crossover.

23. Has being in the exhibition had any effect on your thinking about creative disciplines?

Yes it certainly made me think much broader and I tend to think as a craft-based practice you think about the physical outcome and I think a little bit broader than that now. It opened my eyes to a more open way of viewing this technology and what it can do for creative practices.

24. Would you be interested in being in another show of this kind?

Absolutely I think that those crossovers are so interesting and so important no reservations.

25. Would you be interested in future opportunities with Fast-uk?

Absolutely.

26. When did you first make use of computer technologies in your work?

1996.

27. What formal training have you have had with computer technologies?

Job-related industrial training.

28. How would you describe how you make use of computer technologies in your practice (e.g. concept development, design-to-order, fabrication, pre-visualisation, prototyping, etc?)

All of the mentioned aspects.

29. How have computer technologies had an impact on your practice?

The emergence of digital tools has had a great impact on my work, but it would be very hard to summarise all the many ideas or conclusions resulting from them.

30. What (for you) is the key benefit of using these technologies?

Extending the creative potential of the artistic practitioner.

31. What (for you) is the key limitation of using these technologies?

The lack of direct contact with material in the development stage. Too many possibilities can lead to lack of focus.

32. What is most important to you the finished object or how it was made?

?

33. What do you consider constitutes 'sophistication' in the use of these technologies?

It is not a term I use or have a particular relation to.

34. What does the term '3D computer technologies' mean to you?

3D modelling programmes and related physical development processes, such as RP and CNC.

35. Name up to 5 practitioners that you would identify as exemplary users of 3D computer technologies.

Thomas Heatherwick, Frank Gehry, Jane Harris, Kenji Toki, Ron Arad.

36. In terms of discipline where do you do you locate your practice?

Hybrid practice or digital craftsmanship but using digital tools.

37. How would you identify the community of practice or discipline that you most closely relate to?

It's a hybrid practice but one which is based in knowledge material with material outcomes. A hybrid practice between digital and physical.

38. How would you define the relationship between your work and its audience?

The reason for working with digital media is because it's current - it's contemporary. Its part of our society anything that is information technology in our post-industrial society I think it's really important for creative practitioners whether they make stuff or just have a media-based output to be relevant. I think that we should engage with the tools of the time of the issues of the time that's why I am interested in the digital media - I hope to be relevant. I think that is the key thing that I hope to communicate in a contemporary context.

39 & 40. Do you think there is a trend towards an emerging, hybrid discipline? If so, what role if any does technology play in this?

It is about finding the creative practices of today and tomorrow and the tools that we use they are hugely important. They determine a lot about what the pieces are like and that's the reason we use them.

13.0 Appendix V: Practitioner 4 interview

1. Where did you see the call for PBB?

I think it was on the Rhizome list originally, is where I saw it and then I had a look at the folly site but I think I just printed it off the Rhizome list.

2. Why did you apply for PBB?

Well I saw the call and I thought that that sounds really, really interesting and that's exactly my kind of thing. Then it was sitting on my notice board at work for about two months sitting in front of my desk and I kept kind of going I need to do something about that, I need to do something about that, I really need to do something about that. I came to it when I was doing some other stuff and I was putting in some submissions for some things at home, for two small things at home. The Air Post went the day before and I was rushing around getting those submissions and others, package them all up and go to the Post Office because they had to be in the next day.

I was going on holiday the next day and the Perimeters deadline was when I was on holidays and I saw it was still on my notice board and I still hadn't done anything about it and I thought I have to go to the Post Office anyway. I printed off some old stuff that I had written about the project and I hadn't sort of like… I'm not going to get it anyway. I have to go to the Post Office so I'll shove it in an envelope and shove it in the post as I'm going down there anyway. I didn't get the other two submissions [laughs] but I got 'Perimeters' [That's the way it works]. Yes well it was like I intended to do it and really wanted to sit down and think about it and really make it work. And possibly do something new and at the end of the day I was just throw that in… so.

3. What about the brief made you think your work was appropriate?

It was so lovely and open, in a way its like, I'd submitted that project for a couple of craft exhibitions at home or a Crafts Council Exhibition or things like that and it just kept getting rejected. The only other time I've shown that was a new media festival and it was just sort of thing this just doesn't fit, anywhere it doesn't really fit. I really felt that the 404 Festival in Argentina - I really felt like it got a really good response but I felt it didn't fit in there everyone's kind of like

that's really weird that thing in the corner and that was in a room of odd installations and it still felt that it didn't fit. It was because I suppose it's because its quite…..It goes back to the fact that its designer/craft based or whatever, but I never knew what to ….where to put it. It always felt like I had to rewrite it. Rewrite the stories of it like as in write it up as really crafted piece or write it up as it's really all about the centre of the technology. It was always that thing of having to push it in one direction or just letting it be just what it was and that's ok. It was a bit mixed up its ok if it's a bit of this and a bit of that and its ok if its not high concept and about technology but its fine if it's not about technology that's fine too. Can't really remember to be honest but I think just even the title. I think it just summed it up quite nicely that it was all about the edges and it didn't matter which side you were on. I think that the title of it really struck home.

4. What did you expect to get out of the exhibition?

I didn't really know I didn't really have too many expectations. I was really interested to see what else was going to be there, because I haven't exhibited all that much. So I kind of didn't have any….it was sheer panic. I didn't have any definite plan.

5. Who did you expect to be in the exhibition?

I wasn't really sure, but I probably thought it would be a kind of more Interaction Design maybe or more like people from Critical Design stuff or maybe that kind of direction.

I think some of the people who were in it that I knew about, like Geoffrey Mann, and that kind of thing. Again I didn't have, I suppose because I never really seen a call like that and I'd never really seen an exhibition that covered that. I really didn't know.

6. Was there someone you expected to be in the exhibition that wasn't?

Jayne Wallace and Sarah Kettley possibly and I thought maybe quite probably. Now who else, I thought someone like rAndom International. Have you seen the Pixel Roller project? Maybe those guys because they have done some

smaller things like lamps as well and I thought maybe someone like them or some of the wearable's crowd maybe. Likes of CuteCircuit maybe. Again it comes back to not having too many expectations. I thought maybe more at the arty end of the physical computing type thing.

7. Was there anyone in the exhibition you were surprised by?

I was quite surprised by 'What's Cooking Grandma?' but in a really good way. I suppose the fact they were sitting next to quite physical stuff like Justin Marshall, who you would never ever see sort of in the same space I think. Yes, I was very surprised by that in that it was much less physical or tangible thing. Although they had lots of nice tangible stuff there as well.

8. Did the exhibition live up to your expectations?

Because I really didn't have too many, yes.

9. Were you happy with the way your work was displayed?

Happy enough, it could have been better probably, but that was the space and the work, the other work that was there and the lighting seemed to be a bit of a problem, but that seems to be a problem with the space rather than anything that was controllable. I think in the circumstances it's as good as it could be.

10. What could have been done better?

I suppose the set up. When you have a space like that there's so much you can do and everyone was so accommodating and so willing to work as hard as they could to make a difference. Everyone involved this time was so easy to work with and they were all so good trying to sort it out, obviously under a lot of pressure and stuff. It's hard to say I don't think they could have worked any harder at it. I think the space maybe was a little bit tough to work in. It was a little bit if it could have been a darker space it definitely would have suited me better. The red light took away from the atmosphere and it became the atmosphere of that piece rather than mine. A small space on its own because it does have its aura in a darker space, a little bit of an aura which comes and goes. I suppose it also took a bit of a back step because of the lighting of the other piece again that was something that you just couldn't predict until everything was in place.

11. In your opinion, what was the strongest work in the exhibition and why?

A couple of things stood out for me. 'What's Cooking Grandma?' just the way that they approach it. When you hear them talk about it and when you actually see some of the videos and stuff it's a kind of 'warm and fuzzy' project I think. It makes you kind of feel good and it has something that everyone can identify with. I think that the 'Holy Ghost' chairs are really interesting because of their commercial potential and I'm quite interested in small scale production and stuff like that. I think that the fact that they are using existing forms and changing them is important too. Tavs' work because you see the evidence of the tool, craft and the digital which I think they work really nice. He's not forcing anything one way or the other. He's really working with what the technology allows him to do and what the material allows him to do. It seems like a really natural way of working for someone who is working across a couple of disciplines and he seems to approach it in a really natural way. I think they were all very strong.

12. In your opinion, what was the weakest work in the exhibition and why?

I would say probably me in there with the rest of the stuff it felt kind of unfinished I suppose and it felt even more so I think when it went in there. I was quite disappointed with Usman Haque I don't know what I was expecting but it didn't live up to my expectation.

13. Were you surprised by any work in the show? Why?

Human Beans.

14. Did you think the exhibition was coherent?

Surprisingly so, I think I wasn't expecting it to be as coherent I thought that it would have been a bit disjointed but it was quite coherent. It was all the kind of stuff that I would read about and be interested in and all of a sudden it was there in one place.

15. How would you sum up the core theme of the exhibition?

I suppose diversity within each practitioner. We can all multi-task more than we give ourselves credit for. The borders are only there if you allow them to be there and you can stumble over them then something good can come of it.

16. What did you most like about the total exhibition?

It was the breadth of work covered, definitely. To be able to walk into one basic space and see so many different things. The Art Gallery [Siggraph] is such a big thing but in that big space they didn't cover that diversity of work that was covered in the small space in Lancaster. To see so much in such a small space is really good.

17. What did you least like about the total exhibition?

The space - it worked really well for some things but it just worked less for others.

18. Many visitors to the exhibition would have liked to have seen more technical information – what do you think?

I think that in some cases it would have been nice because the processes are really interesting and perhaps more interesting than what was finally on show. A lot of the work is about process. Some of the work is still work in progress so maybe could have been more of a mixture.
It would have been interesting to get a bit more of the background information.

19. Have you made any new professional contacts because of this exhibition?

New Media Scotland.

20. Have you received any new opportunities because of this exhibition?

There have been one or two others but nothing has come to anything yet. Had a lot of interesting emails – I've had a lot of students wanting to read my thesis and things like that. Because it was one of the one's that was in the write up that was on Rhizome I got a call from the guy on the Boston Globe. He writes the Personal Tech Column (he's big into RFID) so he did a piece on me. So that got

me emails about people wanting to buy one of them because they thought it was a product. Yes there have been bits and pieces.

21. Has there been any impact on traffic to your website because of the exhibition?

Massively. About ten times the amount of the monthly traffic. It went up from around fifty or sixty a month to around five hundred in October and something like three or four hundred in November.

22. Has being in the exhibition had any effect on your work?

I think it will. I think because works been so busy over the last couple of months, I'm supposed to have one research day a week. The last research day I had, I think was in June. So it definitely will, I'd kind of left that work behind for a while for the last year since I started the job in Belfast. I got back to doing more textile work and I had a bit of a hankering just to go and make more craft objects again, just go and make something and not worry about how it connects and if the sensors are going to work all day or not. Just go back and make something which was beautiful again which I felt I haven't done in awhile. Make something for the pure joy of making and suddenly have access to a whole raft of new equipment. So there has been a lot of learning and experimenting and doing quite dull and boring things just to get a handle on what the equipment is capable of. So for a good year, year and a half I really hadn't thought so much about that kind of work again. So definitely last night it really felt… after the seminar [symposium] its like I want to go and do some work. It's always the same after, its yes I want to go and do work again. Unfortunately after the seminar I had to go home and do a pile of other stuff and I haven't had a chance to do any work yet but I think it definitely will.

23. Has being in the exhibition had any effect on your thinking about creative disciplines?

I think it's kind of crystallised a bit more what I've been thinking already. In a way I don't fit in any of the boxes that are out there at the minute. I quite agree that so many other people in one place that don't particularly sit comfortably in one area, but that are happy enough with that. It's made me feel better about attempting that sort of thing and just get stuck into it.

24. Would you be interested in being in another show of this kind?
Yes, definitely if the opportunity arose.

25. Would you be interested in future opportunities with Fast-uk?
Yes.

26. When did you first make use of computer technologies in your work?
I'd say second year at college - 2000. Just doing simple things in Photoshop making 3D sculptural shapes not knowing what they were for or what they would do. Then visualised them in all kinds of scales and all different scenarios, as products and as installation type things.

27. What formal training have you have had with computer technologies?

Self taught as an under graduate. Teaching other people, we had one computer in the department and I was the computer technician because I was the only one who wasn't afraid to push a few buttons and have a root round if something went wrong. We did a project for Dell in my fourth year so they would give us some computers. Less than no formal training in my under grad and then I did my Masters which I thought would teach me maths. A bit of basic programming (C++) and being around computer technicians if something went wrong I would make them explain what was going on, rather than just letting them fix it for me.

28. How would you describe how you make use of computer technologies in your practice (e.g. concept development, design-to-order, fabrication, pre-visualisation, prototyping, etc?)
Already answered.

29. How have computer technologies had an impact on your practice?
They have allowed me to do things that I want to do and did not think were possible. They have allowed me to explore some means of expression like bits of animation which I have had a bit of an interest in but to be able to link that in a

more integrated way to what I'm doing. It had some meaning just making things move round the screen. For me that is the real positive impact it has had. The negative impact is that I spend much more time in front of a computer screen than actually physically making because it takes, because it's not my area, more time to do simple things. It can get really frustrating because it takes a long time especially if I'm getting something ready for something in particular. It can take ages just trying to make one little… trying to get it to read the number off a tag. I try to get it to read the right number and do the right thing I spend so long doing that that I don't have time to lavish attention on the final piece.

30. What (for you) is the key benefit of using these technologies?
Already answered.

31. What (for you) is the key limitation of using these technologies?
My limitation is my lack of knowledge and lack of trying to gain that knowledge or familiarity. I'm like a Magpie its oooh I want to try that as well as that and that because I get bored and move on.

32. What is most important to you the finished object or how it was made?
It's a combination of both, thank goodness neither one is more important than the other because I love the process of making, which goes back to having the craft background I love to make. If someone tried to pin me down and describe myself I would say I was a maker more than anything else because I'm quite happy I do love some of the stuff that I make. It's quite laboriously made for someone that got out of embroidery because I didn't like stitching - I will happily sit and cut up little pieces of paper and tie them all together for hours on end. I do love the making, I think especially when you work at multiple processes when you work across, even within textiles, construction and print or stitch seeing the evidence of the process with the hand or of the machine. That work is really more interesting for me as well as sometimes it can be incidental or it turns out something beautiful and meaningful at the end. At the moment I'm probably more interested in process than finished pieces but there's nothing

nicer than seeing something at the end. You're never happy with it at the time but looking at it a few months later you think that's not too bad.

33. What do you consider constitutes 'sophistication' in the use of these technologies?

I think it means at large, at least that's what I would like it to mean. I think at large people think it has to be complex and quite smooth and seamless and that whole ubiquitous computing type ideal. Everything will be invisible and beautiful and work even if you don't know why it's working or what its doing underneath looking real sophistication using the appropriate method and using it well. Using the right tool for what you want to do if it does it and does it well. It doesn't matter if all you need to do is switch something on and switch something off. In a nice way I think that's real sophistication is knowing when to stop putting technology in. Knowing what is enough -simplicity is sometimes ok.

34. What does the term '3D computer technologies' mean to you?

The first things you think are 3D Studio Max and Rhino and the 3D modelling software. Can't say it means anything in particular to be honest. Tools or rapid prototyping it's just a tool.

35. Name up to 5 practitioners that you would identify as exemplary users of 3D computer technologies.

CuteCircuit, Jayne Wallace, Emily Conrad, Sarah Kettley and Hazel White, Geoffrey Mann.

36. In terms of discipline where do you do you locate your practice?

Already answered.

37. How would you identify the community of practice or discipline that you most closely relate to?

It depends on what I'm working on at the time totally. Sometimes I'm closely related to traditional textile practices and sometimes the way I wrote up for my thesis it probably sits quite firmly in more HCI type Interaction Design

situation. When I've shown the work since it sits more in the making, object orientated.

38. How would you define the relationship between your work and its audience?

Personal I think it comes back to the stuff that goes on the body or being interested in the body is a location as an entity it's never going to mean the same to two people because it's personal. It's all been a personal starting point about my own habits and it's gone off into more general direction. It goes back to being forced to do fashion at college, which I hated at the time but its gone back to fashion theory and how we express and dress ourselves. It's very personal and will probably mean nothing to some but others will pick something up.

39. Do you think there is a trend towards an emerging, hybrid discipline?

Yes I think so. I think that at the moment there are hybrid things happening within pre-existing disciplines. I think that you see it everywhere particularly in textiles and I think that it is starting to branch out like the Interactive Products course in Dundee in academia. There's all that terrible academic politics stopping it happening on a more natural level in a lot of places. At the minute I'm doing some work with a ceramic student. The reason I am able to do that with him is because one of our researchers gets on really well with the ceramics faculty and there's no tension. I haven't been able to do work with other areas of the college, which I should have, because of people fighting over money from different faculties.

In the real world it's obviously harder and still I don't see, with the varied experience which I have when I finish my contract and go looking for something in the real world - no one's going to take a chance on me because I'm not a specialist. There are not a lot of opportunities for someone who comes from a really hybrid background. At the moment it's probably putting people off because the only place for it is within academic research.

40. If so, what role if any does technology play in this?

It's a very central role and it's a central crossover point it's allowing people to move from one area into another because there are common technologies starting to emerge or similar technologies or tools which they can use in one discipline that they can transfer to another.

I think it's the crossing point. In fact people two or three years younger than me have grown up in a totally different technological age from the one that I grew up in. They are so much more comfortable. Even when I go back into college to see what the group or Degree Show from that semester to see the amount of digital stuff that's coming out as opposed to four years ago. Three or four years ago when I graduated there were two of us in my year.

14.0 Appendix VI: Practitioner 5 interview

1. Where did you see the call for PBB?

I was on the internet, some blog website.

2. Why did you apply for PBB?

It was quite close to the deadline when I applied, so it was a bit last minute putting the application together, but the way it was described, the brief and description of the exhibition, really summed up what I was doing. It was quite nice to know there were other people trying to do the same thing. That's why I applied. From my education in 3D design, then going into such a traditional department with RCA, it's quite stuck in intimates and stuck in its history and it's thinking its better and it's not sometimes. So coming out of there producing pieces using art technology and going back and doing fine arts in material form, sometimes you feel a bit lonely. It's a bit weird, but sometimes and there's no-one to understand you, so you might not get these exhibitions, especially with the glass work I produce. Some people can't understand the difficulty in going from technology into material because some programs don't…well…if you're making animation, or a piece it's quite different; you're creating forms which are beyond your imagination. I think this exhibition helped make me understand that other people are doing the same, or trying to push a hybrid practice.

3. What about the brief made you think your work was appropriate?

I think it was the convergence between art and technology because that statement is very simple, but sums it all up. That's what it is; the coming together of two different disciplines and all of a sudden you're making this new hybrid practice, as you say, but then 'hybrid practice' is such a general term. It's more ideal sometimes to call it 'digital craft' depending what discipline you're coming from. It'll be interesting to see how it gets defined, because it might be this area that never has a definition. I think 'convergence' is a nice term and that's what, from the highlights that's what the brief was.

4. What did you expect to get out of the exhibition?

It was a network for me. I'm 26 pretty young into this art, design, craft world and it was just having a platform for showing my work.

5. Who did you expect to be in the exhibition?

And I kind of know some people, I knew Tavs [Jorgensen] would be in it, he's in bloody everything, and Justin [Marshall], it's the same crowd in a lot of these events. What I liked is that I also saw that it said 'craft' and it said 'art' and that brought in a whole new network of people to talk to, network and contact and that helped me generally because in my aspirations to going into teaching and a possible PhD after that trying to combine both and create students who understand that there is traditionally one thing but you've got to keep on pushing it and you can add new technology. Technology is such a brilliant term, in ten years time technology could be a hands on experience rather than an alienating experience as it's previously been. That's why I applied and am trying to get into it.

6. Was there someone you expected to be in the exhibition that wasn't?

There are a couple of people I've seen and I can really appreciate the work and I don't know why they didn't do it. There's one Japanese guy called Kenji Toki. His work is very interesting and very beautiful and it's such a nice connection between tradition and technology. The lacquering, I can't remember what it's called. Possibly Gordon Burnett, but I've only seen some of Gordon's work so I don't know if he should be in there. There is, I did a dissertation on, there is a South African/Australian resident called Gilbert Riedelbauch, these guys are coming from the craft area almost and I think that might be the whole thing about the art/craft world. There are always collision – craft people are really strong about who they are; they're craft people, they're 'makers' and they don't want to be associated with the art world and vice-versa. Maybe the way the brief was set up, they weren't going to apply for that reason.

It surprises me. This is one of my worries as well, in the brief there was a picture of an object. That might have been a CAD rendering, was it? But to me it could have been a real object. So it was interesting and it also said 'sculpture' and just because of the job it is, you can't expect it to be a 2-D there's a lot of residencies and a lot of funding right now and it's all about 'distant practices' – alright, I could apply for that. '2D only'. That's narrow indeed I think.

7. Was there anyone in the exhibition you were surprised by?

I think there were some obvious ones and some surprises I didn't expect to be there, but it was very welcome, I found it very fresh. I don't think there was anyone I thought "This is wrong". This is not a negative, but Justin's piece. I really appreciate his work, making a connection with industry, but I don't know…the big piece, the wall piece is very good, but I personally didn't get the 'Morse' code piece. It didn't add anything, so there was no point in having it there. You could have on and it made the same statement.

8. Did the exhibition live up to your expectations?

Yes it did. It was good for me because it was one of the first times I had actually seen my work put up. When I installed it that day, it was the first time I'd seen it, because it had always been on computer or in my studio in bubble-wrap. It was an interesting/weird environment because it was an office. My work is meant to be taken from the everyday world, freezing a period of time, so why shouldn't it just be in an office block because movement and motion happens in there. I suppose it didn't really distract from my work that much. In a few photographs the radiator and the blinds were a bit disturbing but they're Photoshopped out now, so it's fine! I think it did live up to my expectations though, yes. I never knew much about Lancaster and didn't know what CityLab was. I had seen previous exhibitions that you had been part of, so I roughly knew that part of it, but this was completely different in a way, so it's good. If you'd just done the third 'Intersculpt', then you wouldn't have been pushing it and that's what this is meant to be about, because this is meant to be the evolution of a new practice, so yes, it lived up to the expectations and surprised me at the same time.

9. Were you happy with the way your work was displayed?

You can't do anything about that, so that doesn't bother me. I've had worse spaces and I've had better spaces, but no, it was fine. The lighting, what I did like about the space actually, was that previously I was meant to be in-between two people and I thought, no that's going to be a disaster because the two pieces were one of the big lights. It's almost like a cocoon. You walk into that world and see what's happening; you walk round it as well.

Especially the windows as well. You go past them and it's almost a still life in itself and you get to walk into them and that's really interesting and I think the way it was lit and displayed, it had its dramatic touch.

10. What could have been done better?

I think it had a major struggle in that it had 'Lancaster' next to its name and I think people, it was on a lot of blogs but you can't do anything about where the location was, but I think it was well-advertised. I saw it on the internet quite a bit. Lionel's piece, that's been covered so much because he has so much backing and that helps.

11. In your opinion, what was the strongest work in the exhibition and why?

I think one of the strongest pieces I liked, but I don't think the artist knew it was that strong, was probably the 'What's Cooking Grandma?' [Human Beans]. The presentation was very interesting, but perhaps the outcome was too gimmicky and took away from the moral issue. That was interesting but you didn't need to have the fire, it was a bit too…there was just something about it I didn't get. I love the concept but not the application. I liked Lionel's piece as well. That was an interesting piece of work.

12. In your opinion, what was the weakest work in the exhibition and why?

The weakest work, because I didn't understand it and thought it could have been explained a little more, I can only describe it as tin cans. I hadn't got a clue what it was about. I just didn't get it. Was it a wireless catcher? ['Wi-Fi Camera Obscura']. Yeah, I just didn't get it – I could see where it was coming from, but then, perhaps that's a side of me, I like to see but there was something about that … a second thing, Tav's glass bowl - I think his making is very interesting but his outcome falls short. What did you think?

13. Were you surprised by any work in the show? Why?

It was all very interesting. 'Surprise' is quite weird. I'm just trying to think room-by-room. I was surprised by the sheep. I could understand the principle, I could see the object and the animation, but the surprise to me was "Why?" Why

do it? I suppose his proposal to you showed you a lot… 'cos at the end of the day it was just a sheep with a really badly drawn plane on it. I couldn't get it at all. I was more surprised for the artist. Why did you do it? I think that was my surprise. Yes, but I don't know if he meant it to be funny. I'd be interested to read something by him, perhaps…

14. Did you think the exhibition was coherent?

Yes. I think it didn't have 2D objects, it covered a lot of ground and disciplines and was a good showcase for the possibilities of what is happening.

15. How would you sum up the core theme of the exhibition?

I think the majority of objects, what you can get from it is that there are a lot of fresh perspectives out there. Sometimes perhaps some of the objects were very loosely related to the hybrid practices, they're artists, they're designers, so I think it was almost a snapshot of a lot of things and that was interesting. I kinda thought of my work there…I brand myself as a 'product artist' and as far as I know no-one else calls themselves that and it's quite a nice new little realm, because no-one can say "No, that's wrong". I think those pieces, because they come from the art world, they are very material-led. That worked very well. It's new objects that can't be defined, it's an undefined discipline.

16. What did you most like about the total exhibition?

The diversity of it. There aren't many places you could put a massive red horn next to four glass bowls and a tea towel. It was quite daring in that sense. It was very random; the objects weren't coherent to each other, but the underlying theme was. People are out there trying out new technologies, bringing them back into the art world/craft world/design world. That was fresh. I liked that everyone there was willing to make a mistake and take a risk.

17. What did you least like about the total exhibition?

I think I was ok with it. I didn't come away from it feeling it fell short – I think it did what it set out to do. There are no negative thoughts from it.

18. Many visitors to the exhibition would have liked to have seen more technical information – what do you think?

It's pretty strong to my heart, because I'm process-led. I would have probably showed a running DVD of my work, because that's how my website works, and there have been a lot of negative comments about it because it de-mystifies it. But it's about thinking/making/making/thinking - you're actually thinking about the creative process and that's really important because if you're using new techniques it's important to make them really creative. I've been to a lot of these places and it's become like a tradeshow and it's boring now. I was at a V&A thing to do with new technology and the Metropolitan Works was there and they were hosting the whole thing, I think they funded it and at the end of the day it was a trade show explaining what they could show and "Oh that costs a lot of money" and sometimes you don't want to see that. You don't want to see that it costs a lot of money to do something, so I think if it was…I think maybe that sheep and maybe Lionel's piece as well were showing how it could be done. I don't think we should show how material was made, or machines…in an art gallery, you wouldn't expect to see how the artist painted. Perhaps you should see his thought process.

19. Have you made any new professional contacts because of this exhibition?

20. Have you received any new opportunities because of this exhibition?

It just kind of re-affirmed a few. I had a couple of enquiries about my work, prices…and that scared them off [Laughs] and a lot of people who understood the technology said; "Well, you could make loads of these pieces" and I told them it's not really about that. Although I can make the piece, it's then worked on by hand, so you can't make multiples and I wouldn't – you just don't do that type of thing. There are a few people who I'm talking to and I'm very interested to create something. Going back into a physical…it'd be quite interesting to bring that back into glass or ceramics to see how generative designing can be in glass. It'll be quite interesting. He's interested, but not confirmed.

21. Has there been any impact on traffic to your website because of the exhibition?

Yes, it got quite a few more hits than usual. A few contacts, people just randomly sending me emails from the website. There's something happening in

Elle Decoration Russia because of it. I don't know how vague that was. They saw the work on Flickr. They saw the photographs and got in contact, so Russia may be my place.

22. Has being in the exhibition had any effect on your work?
23. Has being in the exhibition had any effect on your thinking about creative disciplines?

As everyone says; it allows time to reflect - to see a piece in its purity rather than bits and stages. I got very selfish and got a bit of a glow, because I like seeing my work when it's finished and enjoy seeing the process. I like hearing the positive and negative comments and opinions from it. I don't think it'll change the work, but it might make me do more, quicker, but that's all financial implications. I applied for the 'Future Voices' in craft thing, made up a new brief and sent the same photographs and that was perceived very well so far. That'll be interesting because that's taking this work into a craft environment, even though there are a hell of a lot of argument about what craft is at this point in time. I'm just trying to get these pieces out more. Let people see them and between disciplines, try to maybe put them into a predominantly digital exhibition, design it and just try to cover them…because at the end of the day this is in the middle and all this is happening round it, so… if I can get to do that.

24. Would you be interested in being in another show of this kind?
25. Would you be interested in future opportunities with Fast-uk?

Definitely, because I think you guys are promoting something that's very dear to my heart and no-one else is doing it, which is crazy. That exhibition could have easily held its own in London. It would have got a hell of a lot more press because of the location thing, but if you go to America that would get a different crowd, a different reaction. I think it'd still be very positive. It's not been a negative experience for me, so any future pieces…I never do the same thing twice. If it was with you guys again I'd so something completely different.

26. When did you first make use of computer technologies in your work?
27. What formal training have you have had with computer technologies?

28. How would you describe how you make use of computer technologies in your practice (e.g. concept development, design-to-order, fabrication, pre-visualisation, prototyping, etc?)

It'd be when I was an undergraduate, being taught by Gordon [Burnett]. I think maybe 1997 and at that point I was really interested in…I think Gordon had just come back from Australia and was doing the weird cup things, so I tried this very simple object. It was alright – very expensive and small. I think it was the Stratus machine at Gray's? No-one else at the college was doing it and I was really interested. But because the object was really small and the object was meant to be bigger, I couldn't do anything with it. At that point I should have probably cast of it and could have had an amazing career of casting ceramics…kind of cuttlefish effect, but I didn't look into that and wasn't really encouraged to either. It was more "Ooh, someone who is not an industrial designer is using rapid prototyping", so I kind of stopped after that and I was using, was it the 3 Axis milling machine? Incredibly basic software, but it was interesting seeing how the computer code works. It was two or two and a half/three axis machine at the studio – a tiny thing that the guys who are industrial designers use. A beautiful machine, very ugly at the same time. I thin it is very beautiful – the paths it makes is an exhibition in itself at times. I was always using Photoshop and Illustrator to visualise my work. At that point I was using film animation, very basically, mainly with Flash, using it as a flick-book, which worked really well for me. Then I went into the RCA and you have to do a five minute chat; introduce yourself, where you've come from, what you want from the RCA. I wasn't a ceramicist or glass maker, I could do both but I wasn't a specialist. So I said to them "I want to use animation and film", all these different kind of crazy new thoughts in ceramics and glass and everyone was like; "Ok, fair enough…" I had some friend in design products and I was discussing the moth idea I had, and the bird as well – just capturing movement. One of those guys was an absolute Rhino whiz and said; "Ok, you make this for me and I'll do that for you" and I made something three-dimensionally out of plaster and came back two days later with very closed-eyes and he'd modelled this bird and I thought 'fair enough, I've got a rapid prototype'. It was out of SLA® which was very expensive and tiny. So then I had to start figuring out how to do these myself and also how could I make them a fair size? It was all very well having small objects, but nobody could understand. At that point I sat

down and took a couple of weeks out and learned what I needed to know about Rhino. I had a fairly good knowledge already. I was coming from animation and bringing it into Rhino and getting rapid prototyped at the Hothouse in Stoke, so they were missing bits, cutting into each other, everything. The computer never knew it wasn't meant to do that - it was almost giving me a very real aesthetic… the machine didn't like and I quite liked that. The Hothouse said; "Oh, there's a few red bits on this and all the triangles are inverted" and I said if that's what it's meant to be like then do it and I'll re-build it afterwards, I'm fine with it, which got a bit of criticism from my tutors who said "You should leave it, because if you're talking about the purity of the machine, then leave it – don't fix it". I thought it was another interesting side to it and I was more interested in getting this form out. Doing these large pieces, using the new technology and starting to use digital animation. It was a basic cup and saucer and then a ripple goes straight through it. It's very beautiful. Three simple frames, you hear something blowing and see the cup getting blown and the water rippling. A nice research, development and design kind of thing. So it's been going on and off, but it's never been the catalyst for my work. When I look back at Gray's I think that if there was no way to make it by hand, there's no point in doing it. Now, if I can make it by hand I will make it by hand, but now my work can't be made by hand and I need a computer to help me with it. So I think that's my earliest reflection on computing.

29. How have computer technologies had an impact on your practice?

30. What (for you) is the key benefit of using these technologies?

31. What (for you) is the key limitation of using these technologies?

It keeps me going. It's a very fresh way of working. If I come up with something in my mind…like when I first made the birds, I knew roughly what I wanted to do, because you see birds flying about, but I didn't know exactly what it'd be like but using the computer it materialised the invisible and I was like; "Fucking hell, that's good!" I was interested in that, and seeing it in three dimensions was a completely new experience, so the key benefits for me were…it's obviously a matrix. I can see the different way I am. It keeps you going, gets you up in the morning. This sounds stupid, but I can walk about, if I've been working with the computer and am still thinking in that way, I start imagining things moving and

how it'll trace, leaving a trace echo in the sky – it's slightly sad and worrying! I think anyone who tried to talk to me, do a bit of counselling might go mad.

[Key limitation?]

Well, it's expensive. The financial implications. If you create two bits of RP that size, it's not cheap. And to then get it finished, painted and sprayed – it's not a cheap process. Apart from that, there is the learning curve, because it's a new skill, but I'd say that's a positive, not a negative.

32. What is most important to you the finished object or how it was made?

That's a tricky one for me. I think it's pretty even. I'm now writing a brief for the students on Friday and it's all about making a creative process. These are all traditional throwers or glass makers – they'll blow something just because it's a means to an end. I'm trying to deconstruct it, just to make something different. You must have seen the big YouTube thing - the 'Sketch Furniture' by Front? That's beautiful to watch; the thing's like toothpaste, but it's a theatrical performance and that's the art going throughout it and I think that's really nice. With the cups and saucers I could have stopped with the animation, but it's almost making art to make art or making design to make design.

33. What do you consider constitutes 'sophistication' in the use of these technologies?

That's a difficult one. I don't know. Give me an example. I think it's probably connected to the previous question to do with process instead of perhaps how people have applied the technology. There are people who use technology for technology's sake and that can be very crude. It's pointless. A lot of industrial designers use it when it's not necessary in the slightest. I suppose that was the point for me of what the exhibition is about - is that it's a creative way of the application of technology and that's sophistication in my eyes. Being very aware in the same way you'd use another material or another tool. Some people would use a hammer to get a screw out but you could use common sense and actually think about it.

34. What does the term '3D computer technologies' mean to you?

That was one of the reasons I did it just so I could get something in my hand. I teach at Farnham ceramics, metalwork, jewellery and the applied arts and I'm doing a new course and there is a new guy called Darren Stokes who is really interested in creating people with transitional skills so that people can leave college and not have to get a job in McDonalds. They can find something to do and can apply their skills too. I'm working on showing him visualisation techniques Photoshop Illustrator and Zion [?], this terrible Mac modelling technique. So we're working away and they saying; "This is fantastic, different ways to show our work", but I want to feel it in my hand. I want to see it. The same as everything else, it's learning for doing. You have to make the mistake to understand. The reason I use technology is because my work demands it. Some people don't think these pieces are made with technology, they look very organic and you can relate to them and there is familiarity of the birds moving…

35. Name up to 5 practitioners that you would identify as exemplary users of 3D computer technologies.

I would say Front, even though I know stuff about them and don't particularly like their attitudes to what they do and they have got a very good team of people behind them to do what they do – hence the name Front. I think they've had to be creative and had the initial idea and it's very clever for them to say 'this is what we want to do, how do we go about it, there's someone over here'…I think that's a very good way to do it and the work is very poetic. Kenji's work has a nice balance between tradition and technology. I would hope myself. There's not many people out there. I can't remember his name, but he's huge just now – makes very mechanical art. Sculpture. He's 24 or 25 Conrad Shawcross. Yes, one of my mates did the designing for him. It's very interesting work – annoyingly good! David Goodwin, a jeweller who won the New Designers prize a few years ago and makes use of amazing little intricate jewellery pieces. There's also another jeweller who graduated from the RCA this year, Jo someone, I can't remember her surname. She pixelates bracelets and then animates them and you can stop it at any point. It's not crude, but there are pros and cons about the work. I think it's a starting point and could go so much further. I like the bespoke nature of the animated products. Ron Arad.

36. In terms of discipline where do you do you locate your practice?
37. How would you identify the community of practice or discipline that you most closely relate to?

Self-defined product artist [Laughs]. It's one of those things that you always get asked; is either are you a designer are you a maker… are you a ceramicist? I do a bit of everything. I touch a bit of every medium I can get my hands on. It's because the project demands it. At the end of the day it's just a material and it should be represented that way. I think I'm very traditional in that way. I think the 'artist' comes from the process. All the objects can be products, but I do have a very alternative way of making it – I sit down at the computer and I do outsource a lot of my work, just because I can't make it here. Three other guys in my studio are industrial designers. Being an artist…the cups and saucers could be, one day I hope, very successful pieces of design. They work, they exist. The whole idea of a bespoke set, you could customise, you could go crazy and apply that same theory to it and materialise something that has no material properties. You could apply it to anything. I've done pieces in materialised sound, like the Jurassic Park thing – the dinosaur does that [slaps table] and the water moves. That's the artist side of it, the vision side and imagination - that's how they bonded together and its very similar to the convergence idea. There are a lot of designers now who are creating artistic pieces and they will not be called artists.

38. How would you define the relationship between your work and its audience?

I think it's through familiarity. All my work is…people can relate to it in the way the moth flies round the lightbulb. Everyone has had that experience. The initial bird, which was a pigeon, was my mum's budgie which flew round the house. The cup and saucer, everyone blows on a cup of tea. The candelabra came from walking down Portobello market. Everyone's had these experiences, it's not just me. I think the new technologies people can't relate to it sometimes. People are relating to my work because they've had the experience, at last that's what I'm hoping for. At my RCA show I had a bad space and I made a nice installation of a house. Very straightforward, very slick. It had the bird, the moth and a TV showing people how the process works. All of a sudden everyone was like; "Right, I know exactly where I am, I can relate to it" and that's why the

technologies didn't alienate anyone at that point. Sometimes it's a very alienating process and discipline and that's the connection I have with my work and audience.

39. Do you think there is a trend towards an emerging, hybrid discipline?

40. If so, what role if any does technology play in this?

It's a rebel movement in a way. It should start with a first year foundation - people questioning it and being inquisitive. That's how I came about it and how my work started. They challenged me. That's the hybrid practices; people challenging what exists already and because they're challenging it they're manifesting a new framework. It'd be very difficult to discuss my cups and saucers alongside someone else's cups and saucers in the way that it comes from somewhere else. I'm interested in process. I'm interested in animation, but it can't be related to animation because I could be a sculpture – it's all different kinds of influences. I think technology is a catalyst at this point, but as we discussed earlier; maybe in ten years time the technology will be something different, but it's never going to stand still. It's helping how it's emerging, but 100 years ago a kick wheel was the latest tech but now it's traditional. It'll be interesting to know what the new tech will be. This 'Future Voices' and craft type thing is kind of approaching the subject but not really.

It's a valid experience which has been very good for my work especially and I would be very interested in other possibilities pending funding. It needs a new breed of people which, hopefully, is what I am to start a new discipline. But as it happens another breakaway thing will happen and there'll always be someone trying to create a new hybrid practice.

15.0 Appendix VII: Practitioner 6 interview (response by email)

1. Where did you see the call for PBB?

I think our research cluster was informed by John Marshall of this opportunity to exhibit.

2. Why did you apply for PBB?

The opportunity to exhibit in a venue I had no previous experience and with a broad range of makers and artists working in related but sometimes distinctly different fields.

3. What about the brief made you think your work was appropriate?

My work often falls between art, design and architectural decoration and therefore I believed my work fitted the cross boundary nature of the show.

4. What did you expect to get out of the exhibition?

I never know what to expect, I was hoping for some connections to be made with other practitioners working with architectural based work.

5. Who did you expect to be in the exhibition?

I did not have any expectations

6. Was there someone you expected to be in the exhibition that wasn't?

No answer.

7. Was there anyone in the exhibition you were surprised by?

The exhibition was diverse enough not to be surprised by anything

8. Did the exhibition live up to your expectations?

The exhibition worked well visually, within the limitations of the space. I would have liked to make more links and contacts than I did.

9. Were you happy with the way your work was displayed?

As far as the rather bleak and sterile space allowed, yes.

10. What could have been done better?

The organisation and installation were faultless and the staff at folly extremely well organised and professional. Again the only negative element was the actual space itself.

11. In your opinion, what was the strongest work in the exhibition and why?

Lionel Dean's [Holy] Ghost chair worked well and in this exhibition setting (i.e. low artificial spotlight, with no natural light) did have the ethereal quality I assume he sought with the piece. The projection pieces also worked well, especially the landscape text piece by Baily [and Corby].

12. In your opinion, what was the weakest work in the exhibition and why?

The wi-fi camera obscura. I would not say this was a weak work just that it sounded very intriguing as a concept but I was disappointed by the visualisation of the signal data, to abstract and undefinable for me.

13. Were you surprised by any work in the show? Why?

The human beans project surprised me I think because it crossed an unexpected boundaries into documentary/social science/public service? Which I was not expecting at a technology centred exhibition.

14. Did you think the exhibition was coherent?

Not really, but I would not say that was the point or aim of the show.

15. How would you sum up the core theme of the exhibition?

Don't make assumptions about art/design works which use digital technologies, they are as diverse as any other forms of practice.

16. What did you most like about the total exhibition?

Seeing and experiencing the unexpected.

17. What did you least like about the total exhibition?

The office-like space.

18. Many visitors to the exhibition would have liked to have seen more technical information – what do you think?

If done well and intelligently (but not too technical) documentation of process can add to a work.

19. Have you made any new professional contacts because of this exhibition?

Contact with folly which I was not previously aware of.

20. Have you received any new opportunities because of this exhibition?

No.

21. Has there been any impact on traffic to your website because of the exhibition?

Not known.

22. Has being in the exhibition had any effect on your work?

Not as yet.

23. Has being in the exhibition had any effect on your thinking about creative disciplines?

No answer.

24. Would you be interested in being in another show of this kind?

Yes.

25. Would you be interested in future opportunities with Fast-uk?

Yes.

26. When did you first make use of computer technologies in your work?

1996.

27. What formal training have you have had with computer technologies?

Self taught on some elements, workshop trained on some and worked with technical facilitator on others.

28. How would you describe how you make use of computer technologies in your practice (e.g. concept development, design-to-order, fabrication, pre-visualisation, prototyping, etc?)

Tooling, actual production of piece, master models, physical visualisation.

29. How have computer technologies had an impact on your practice?

All technologies, digital or not, I have used have had an impact on my practice, whether consciously or unconsciously. I believe your experience of the world is framed by the technologies your engage with the world through.

30. What (for you) is the key benefit of using these technologies?

Degree of complexity, accuracy and detail otherwise unachievable. Quick manipulation of forms within the digital environment.

31. What (for you) is the key limitation of using these technologies?

Expense, time consuming, frustrating, quality of the surface output from many RP processes.

32. What is most important to you the finished object or how it was made?

No answer.

33. What do you consider constitutes 'sophistication' in the use of these technologies?

Recognising the benefits and limitations of each different process, pushing a process/technology to its limits, using a technology in an unique way.

34. What does the term '3D computer technologies' mean to you?

It could mean a variety of things, 3D CAD software, 3D input devices and 3D output devices. To me it means someone is not being very specific.

35. Name up to 5 practitioners that you would identify as exemplary users of 3D computer technologies.

Tavs Jorgenson, Drummond Masterton, Gordon Burnett, Industreal group, Materialise group.

36. In terms of discipline where do you do you locate your practice?

Differing projects I undertake sit in different contexts, but predominantly within designer/maker practice.

37. How would you identify the community of practice or discipline that you most closely relate to?

No answer.

38. How would you define the relationship between your work and its audience?

Again this differs from project to project, sometimes as active client/commissioner, sometimes as an active collaborator, sometimes as relatively passive consumer, others just as a passive viewer.

39. Do you think there is a trend towards an emerging, hybrid discipline?

There are designer maker using digital technologies crossing boundaries, but without an underlying understanding of the materials and processes they are using beyond the digital realm this can result in work which lacks quality and deep understanding of the field.

40. If so, what role if any does technology play in this?

Digital technologies do open up the potential for new practices through the creation of data which can be used for a variety of applications and to control widely differing forms of output device. The ability to transmit data quickly and accurately also opens up new forms of working practice. However for me the useful, interesting, successful and/or convincing applications of digital

technologies do tend to come from people who have concentrated in a particular field of practice.

16.0 Appendix VIII: Creative Director interview

1. Can you briefly explain folly's mission?

What we are ultimately trying to achieve is to explore different creative ways of how technology might influence and mix with the production of art and the experience of art and the distribution of art. Specifically we are interested in supporting and looking at ways of supporting artists working with technology. Looking at how to help audiences understand what the implications might be and also very specifically looking at ways in which we work with audiences and whether they are acting themselves as producers or co producers of content. So encouraging a culture of producers rather than consumers we will hopefully do.

2. Can you briefly state what you do at folly?

My role is Creative Director and that means that predominantly I set the curatorial vision for the organisation. Artistic vision and manage the programme team and the communication team within that which I am also heavily involved in the general organisation in development for the company.

3. How did you think PBB would support folly's mission?

I suppose predominantly I'm obviously familiar with the work of Fast-uk and 'Intersculpt' in the first instance. So my initial interest or expectation would have been in the knowledge of that work. The fact that I know that your experience in developing interesting and new ways of using technology, within an artistic context and specifically the relationship to sculpture and that whole area. That really opens up a new area for us that's not our core - the reason being that it adds another level of expertise into the mix of what we are trying to grapple with. It was based on those initial ideas of my understanding of what you're trying to achieve through the 'Intersculpt' of the previous year I wasn't familiar with the one before that.

4. What did folly expect to get out of the exhibition?

There are a couple of things. One of the things that we have been particularly strong on which has been shaping our artistic vision. This gave us the opportunity to flip that around and test it back again in a different way is the very strong absence on process rather than product and in the distribution and

experience of the work we are involved in. This was much more, in my view, focused around product and tangible stuff that people could more readily experience. So it flipped back so we had been pushing and pushing around one sort of agenda and it also sat within us and how we do work in the gallery space and then moving out of the gallery space, working in a different way which is incredibly intangible actually and that's the strength of what we do, but for audiences that's quite hard to grapple with. So this gave us the opportunity to flip that back again and show some stuff that people could actually physically experience and see the tangible value in it and give them that kind of experience as a way in really. So that was a really important part of it. So there's that physicality of it which is the primary thing and then specifically working within Lancaster with an audience of predominately Lancashire and Cumbria this area of work is still very new to people. It is still that area of is it art or isn't it, how do we engage with it? We are still struggling with what on earth do folly do and I think that this exhibition really helped us a lot in that area because it touched across all sorts of different art form areas obviously with the general ambition to be what ever it was. It had a relationship to technology in some way and without that relationship to technology those pieces of work wouldn't exist. I think that it probably quite strongly did achieve that and start to introduce those sorts of ideas to people that up to now we haven't always managed to achieve. The other thing for us (totally selfish reasons) is that it was fantastic to be able to draw something which is rooted somewhere in a big urban centre like Manchester and be able to showcase that with folly within Lancaster. Something of that quality of that nature being to draw that out of the big urban centre was quite a bit of a scoop and also the scale of the ambition of the work, the mix of work, the mix of artists within it. Again it's not something we have had the opportunity to do before. When we are working with the gallery space we are either working in partnership as we are now with venues or have a history of working within a very small restricted gallery space where really only one piece really works well within it. Very difficult to do group shows in that context.

5. How would you describe folly's role in the curatorial process for PBB?

I think it was an interesting role, obviously we were involved in the curatorial decision making and the curatorial team were co coordinating that process with artists coming to us but ultimately the curatorial vision was set by Fast-uk. So there was a sensitivity around that, I suppose I was aware of what our role within that and what the opportunities within that could be, but the overall curatorial decision to the project isn't totally the same as folly's so there is a mix within there that we knew that we were working with you to achieve that aim.

I don't think that there was any particular tensions probably we did select some work that I would not have necessarily selected as part of a folly purely exhibition. But that's not necessarily a tension that's bringing in a different mix into the end experience and also offering such a opportunity where you had to think slightly outside the box. Or think of the value that someone else places on something that if you looked at it in a different way or you could look at it that way and therefore it would fit. I think that about half of the show fitted with our curatorial vision and half of it didn't but I don't think that was a weakness. I think that's the strength of the show.

6. How useful was the fast/folly wiki?

Obviously I wasn't a great user of it, I think that it was very useful in the sense that in working remotely it gave people a shared working space. Visually I think it worked well to be able to have the visuals of the artistic work in one place and visually see how they sit against one another and not always have to always be rooting around. So organisationally that was really easy to access. I admit I wasn't a great user of it but I know that [Programme Manager] was. When ever I could feed things through to [Programme Manager] he would be actively using it. In terms of remote working it was very useful. It was also useful when inviting people to see what it was, so saying we were looking at building another partnership there was something visual there to direct people to that was already in existence rather than have to duplicate that work. It was helpful.

7. What kind of practitioners did you expect to be in the exhibition?

I don't know if I expected any kind of practitioner. I suppose I expected a mix of kinds of practitioners and I suppose I expected, because of the nature of your

work and the vision of the project, I expected to be working with artists that are more product led or 3D-led.

8. Was there anyone in the exhibition you were surprised by?

I suppose a positive one would have been Human Beans I didn't foresee that would have manifested itself in the way it did and it wasn't one that I necessarily bought into but actually was probably one of the most successful projects of the show. In terms of its installation, in terms of its work with communities and in terms of the stuff that has been ongoing since it has probably had the biggest impact and is still now drawing in huge numbers of people. So I think that one I was most surprised by.

9. Did PBB support folly's mission?

I think it did up to a point. I think that it absolutely did in the sense in trying work with different artists and trying to introduce audiences to what might be possible if art was working, in interesting ways, with technology and that is the core of what we are always trying to do in different ways. We got to work with lots of artists and through that there was a fantastic learning curve within the organisation. We benefited because of that and the feedback that I have had from audiences, stake holders and partners was that people found it incredibly valuable in the sense that they began to understand what it might be that we could be doing. The only thing with that is that because it wasn't a hundred percent fit with our artistic vision they could go away with a different idea of what it is that folly might be trying to tackle. We are not necessarily so exhibition led in that way and also we are not necessarily so product led. That was a slight conflict with the artistic vision we are trying to drive forward. Overall it definitely enabled us to work on a really broad range of interesting projects with different artists across a range of areas. It gave us those opportunities to work in those ways and it gave audiences a way in. I really do think it gave audiences a way in more than a lot of the work we do because it still has that exhibition feel although we weren't in a gallery it felt like a gallery when you were inside. Obviously there is a starting point to get the person A inside the place but once the people were in there was a language of people walking around exhibition spaces that people already understand

10. Did the exhibition live up to your expectations?

Answered in previous question.

11. Were you happy with the way the work was displayed?

Yes absolutely I was very pleased with the end result of how the work was displayed. Obviously we were working with quite different parameters. Obviously it was being shown within a non gallery venue which has huge implications into how that visually looks and how it feels and how accessible it was. There was a lot that we had to tackle with within there but as in terms of how the work was ultimately displayed in that space; I was very pleased that level of presentation.

12. What could have been done better?

I still think that the choice of venue meant that it was quite hard for people to go in because of the nature of the fact that it's not a publicly accessible space. I think that we could have probably promoted that better in a way that we could have sold the fact that this is a commercial space that is brand new development. People could go in and have a look, but with retrospect it was a bit of a missed marketing opportunity to get people to go there in the first place that might not have gone because it was an art exhibition, then when they got there they found something else. So I think there really was a barrier with that and with the reception and with the whole notion of it being in an office space. Even office workers would have felt put off by that and certainly non office workers would. However, I think that what we did with the space ultimately was really successful. I felt that in the middle of the show that there was a bit of a lull. That really open, large space in the middle could have had more impact and powerfully used I felt that that bit kind of dipped and then picked up again and I felt that that was a bit of a wasted opportunity.

13. What would you do differently if you had the opportunity?

You could argue that we could have marketed... been a bit more creative with the marketing to get people into that space in the first place. Or you could argue that we could have selected a different space altogether. However, we were being opportunistic and I think the partnership the City Council were offering was very opportunistic and worked well for them and for us and everybody. In

that sense it outweighed the negatives. But if the marketing had been tackled differently I think that that was something that could have been achieved. I would have liked to use that central space more effectively. The idea that people could hang out was missing from it. People spent a long time at the show and much longer than any other shows that we have put on. That was a great and positive thing but there was nothing in there other than the work to help them feel that they could spend time there or encourage people to do that. I think that is something that could be improved on.

14. In your opinion, what was the strongest work in the exhibition and why?

I think that the Human Beans piece was really strong for the reasons that I mentioned before and the fact that it had a life beyond those three weeks, we felt as a team that there was a massive amount of work leading up to those three weeks which is ultimately very short time frame. The fact that this piece has had a life beyond that particular exhibition for me makes it very strong and it had, had a real relationship with the community. Obviously it could have been with more people, but the people that were involved had a close relationship with that work and I think it gave it a kind of humanity that often work with technology arguably suffers from the lack of. So I think that was really strong but I also think that there are other really strong pieces of work within the show. Basically the first two rooms, for me, were the best two rooms so Usman Haque's piece although I know Phil is just a bit dubious about that one. I liked the intent I don't if you've talked to Phil about it but he absolutely wants to see the truth behind it, for me I like the intent and therefore I think it is an interesting project in how it's conceived and how it's presented. I also liked 'Cyclone.soc' piece although again originally I felt it was something seen already or by another artist. I suppose I still think that slightly but the way it was ultimately presented and the dynamism that it gave those spaces and the way people have interacted with it made me feel that it worked very well. I also thought that Geoffrey Mann's piece was really strong and that was something that we would not normally show at all at folly. Everybody loved that piece so it was quite interesting to have the opportunity to show something like that we probably wouldn't ordinarily do and it's really beautiful work. I've just forgotten still one of my strong favourites which seems to have offended lots of people,

which was Ben's work which for me I really liked that piece. Like I say I liked the first two rooms were really, really strong and for me it was less exciting as you go deeper into the show.

15. In your opinion, what was the weakest work in the exhibition and why?

It depends because weakest is a funny word I don't think that any of them are necessarily the weakest but, I suppose the ones with the least fit to our artistic vision might be a better way of talking about it. So there are three pieces specifically that I felt didn't really achieve that for me and also for audiences didn't achieve a kind of interactive experience. That would have been Justin Marshall's piece, pieces and Tavs Jorgensen's, bowls and NIO Architecten. When I talked to people around that was a really popular one as well. I just felt that each of those pieces were very heavily product led. There was not any interaction with the work. I like the intent again behind Justin Marshall's work but the end result just felt a bit… It didn't work within the space and I think for an audience member that's coming into a space to see basically some really unusual and dynamic and interactive experiences that they can take part in and that was very cold in my view. Likewise the work with Tavs' bowls. I think the tea towels are great but somehow as it was ultimately presented it lost that sense of how the work had been created. Actually it was how the work had been created rather than the work that was interesting in that particular piece.

16. Were you surprised by any work in the show? Why?

Geoffrey Mann's piece I'm surprised by the very strong reactions people had to that. It's probably something that people very familiar with the idea of looking at sculptural piece in that pristine type of environment. Although that's kind of an art experience, it's a traditional experience of art. I was surprised by the strength of the reaction to that work. For us it's so much about process and taking part but clearly there's a real passion for seeing something really beautiful.

17. Did you think the exhibition was coherent?

I think it was, yes. I think it was quite hard in the spaces because there was the central core and three bits that came of it so it was quite hard to bring together

in the sense that the doors were shut between them so that coherence was quite hard to achieve and because of the breadth of the work within the show. In general I think it was a coherent show. Hardly anyone went in and loved everything. Most people went in and had favourites or liked some bits and hated other bits. It was coherent in the sense that even the work that I don't feel that passionate about that still fit with the curatorial vision of the show.

18. How would you sum up the core theme of the exhibition?

I do think as general core theme it was about new work, for this area, that creatively explores technology across art… I think it was probably less within the mix of architecture and design than was the original intent and that might have been when the curatorial panel there was no one voice saying make sure that there's architecture pieces in there and that kind of thing. A sense of a coherence it was technology-led-practice that basically touching on ideas of 3D.

19. What did you most like about the total exhibition?

If you wanted to make sense of any of the work you had to give it some time. If someone came a long way there was enough there to qualify that time and that's something that we have found really hard to do until now. I was proud of that sense of the ambition of it and scale of it and of the impact that might have on people's experience of it.

20. What did you least like about the total exhibition?

Some of the works within it I probably wouldn't have chosen. Certainly on my own. I least liked the fact that it was hard to access for people. Basically that second half of it - I felt that the first half met all of our objectives and perhaps the second half met more of PBB objectives. Which is fine that's what it was there for.

21. What feedback from the local community did folly receive about PBB?

Great feedback and we don't often get great feedback. The biggest thing was that people were really proud and pleased to have something of that quality and calibre in Lancaster. Not just the sense of scale but the sense of cutting edgeness about it, the feedback predominately was this looks like something

that should be in London. So there was a real sense of pride in that. I think that was the biggest thing that it was successful in achieving and people spent time there, people took their family there more than we have had before. People found that it helped make sense of what on earth art and technology might entail. The other thing is that folly is still doing stuff round here and I think that was part of it.

22. What feedback from peer organisations did folly receive about PBB?

Not so much as we could have done. Feedback from other partners and stakeholders has been positive, other art organisation within the city feedback has been really positive but peer organisations working within this field, I don't think that many people attended. My feeling is that even at the opening which was really well attended its something that we struggle with in Lancaster as a whole is trying to get peer organisations. Even just up the road for an hour and a half or an hour to come and see some stuff here. I don't think that's specific to PBB although I felt that it would have been enough of a draw for people but I don't really think that was achieved. So the amount of feedback from peer organisations that actually attended the show is pretty minimal. I think that people know that it happened and I think probably Manet pushed it and supported it most of those peer groups and I was copied into some really positive comments and pushes that Debbie tried to make to encourage people to come up and take part and have a look. Other people came from places Manchester City Art Gallery because the link with our Programme Coordinator on PBB and there the feedback was really positive. Thinking about it another really strong thing that came out obviously it was on pretty much the same time as the (Liverpool) Biennial and those people that did come did say wow this is really interesting stuff, I'm not used to seeing stuff like this, I think this is more interesting than the Biennial and that was definitely more than a couple of times. So that's really strong but getting those people to come here was a challenge and again in retrospect what we should have done differently was I think we should have opened on a Sunday. We have opened on a Sunday in the past but Lancaster itself is dead on a Sunday but quite a few people that would have come from further a field said to me afterwards I was coming but it was shut on Sunday. There were quite a few quite critical people that if they had

come it could have been valuable. Obviously we had very limited critical reviews of it from peers, we should have considered that earlier and invited people in advance to come and do that kind of work so that the stuff like the a-n write up that we got we had to pull that together in a few seconds. The critic in residence at MIRIAD that we approached could have been approached much earlier so that we could have given more time. There is some ways that we could have got much better feedback from peer but those that did come were really positive.

23. What feedback from funders did folly receive about PBB?

Really great, mainly the great stuff came from the City Council and the County Council, which for us is fantastic. Actually the city council although they have been supportive over the years the key person that was being supportive left about a year ago and we have had to fight really hard for anybody to know that what we are doing is of any value. I really think that PBB and f.city has had a big impact on the local authority relationship in the city. So they were really positive about it and thought it was fantastic. It hits all their boxes about trying to create this area as a vibrant, interesting and culturally stimulating place to live and work. I think that for the Arts Council we actually again had purely attendance from our two key allies within the Arts Council so our lead officer and Sarah [Fisher] our Head of Visual Arts who gave some really positive feedback about the scale, the ambition and the presentation of it. I think again it was really well received, so positive, but I would like to think that we could have got some more people up and touched more people through that it would have been an opportunity to do that. It's my intent to have an impact on other people within the Arts Council except for the routine one might have. Having said that Taylor [Nuttall] received some really positive feedback from the Creative Industry Officer at the Arts Council who didn't attend it but had obviously had heard of fantastic recommendations about it, which was predominantly the City Council chatting about it and showing off about it. So I think the stuff through the relationship with the city and the people they talked to must be the real strength in terms of feedback from funders and the Arts Council.

24. Has folly made any new professional contacts because of this exhibition?

Obviously all of the artists that we worked with - we hadn't worked with any of those artists before so that was a real opportunity for us. We also grew our volunteer database through this particular show because it offered people an obvious way into an arts organisation. That was all great. There were other contacts we could have made and followed up on more fully with the critic in residence at MIRIAD and a couple of people like that. I'm not aware of any professional contacts we have made.

25. Has folly received any new opportunities because of this exhibition?

I'm trying to sense whether some of the opportunities came out because of the exhibition or because of the broader festival as well and some of those will be mixed in between and not just because one or the other and so I think that within the city, it's a small city but the arts organisations have a strong cultural offer but they don't often have the time to talk to one another and don't necessarily collaborate. I feel that based on this and f.city there are many more opportunities for us to pursue of that ilk and people are more willing to work with us because of the calibre of what we can deliver is strong. The press that was covered has been really positive. That has led to more people being aware of us.

26. Has there been any impact on traffic to folly's website because of the exhibition?

No, there was an impact on traffic yes but what's actually happened is that during the period of the exhibition and the festival the traffic massively went up and then it dipped again since because there was less activity. Its now growing again because one thing was it had an impact on our programme because of the amount of capacity resources it needed we had a lull in programme afterwards and that's the reason there was a dip in web traffic. The thing that has had the biggest impact is the Human Beans piece therefore the amount of downloads from that piece after the exhibition has been massive. It still continues to be and it is now drawing on bandwidth now.

27. Has being involved in PBB had any effect on what folly will do in the future?

I think it probably has because it has made us realise that like I was saying right at the beginning about the tangible nature and some ways in for audiences is to better understand the work of the artists that we work with and the work that we do. So I think that will probably feed into our curatorial thinking from now on.

28. Has being involved in PBB had any effect on your thinking about creative disciplines?

I don't think it has.

29. How did you find working with Fast-uk?

Fantastic, really good, really great. Obviously throughout the process both sides learned about things and probably earlier on we should have been a bit more thorough with our negotiations around how we wanted to tackle the marketing side of it as there was a bit of tension there in the middle . I think we could have probably eased that if we had had those discussions more upfront but obviously some of time that's easy to say in retrospect before hand you don't always know what is going to happen or what's going to be difficult. In general the project management consultancy model worked - there was some difficulties within that but most of all many of those difficulties were definitely outweighed by the success of the show, the impact of the show and the calibre of it. The opportunity to work with so many new artists and the opportunity to be involved in that curatorial decision-making element. I think that if we hadn't had that part of it, it would have been more of a delivery role but because we felt very involved in that there was ownership from our side on that so I think that worked well. I also think that the amount of hands on and hands off balance was about right because we didn't know how much you wanted to be involved in the coordinating elements It was about that that I thought the balance was about right and we felt quite clear where our responsibilities lay and where yours did. That could have been difficult but it didn't seem to be, that was successful.

30. Would folly be interested in partnering on another show of this kind?

Yes, actually one of the things that it kind of feeds into is a model for us to consider working with, on an ongoing basis at the same time there's this set within our exhibition presentation of artistic programming the Project Management element of it financially and management wise within our Consultancy Services. Ultimately you were paying us to deliver a service so this is where I think it has got slightly blurry with what our role in the curatorial panel was because ultimately you were a client of ours and we were a service provider of yours. Some of the time that was easier than others because sometimes in terms of negotiating we weren't purely being a service provider we were also a partner. I think that was the only area that made it a bit difficult from time to time. However, built on that experience it's certainly a model that we are looking at further development. It's hard to say because we wouldn't have been able to do it without that project management fee. It's just a fact we don't have that capacity of resources so it was essential for us to work in that way. However, the partnering model is a stronger model so somehow to get that mix. The optimum mix would be what we tried to achieve on a next time. So yes absolutely interested in doing work in that way again. It gives us the opportunity to work on a bigger scale with new artists. Work in partnership with others which we do all the time, this is probably the biggest partnership we've worked with in terms of exhibition but in general most of our work is in partnership with others but we are very interested in that kind of exhibition presentation partnership that's possible with specifically arts organisations that don't already have specialism in this area. That is where we would push it more.

17.0 Appendix IX: Programme Manager interview

1. Can you briefly explain folly's mission?

folly's mission is an ever evolving mission, principally we have a distributed programme across Lancashire, Cumbria and on line. We will eventually have a venue back in 2008. So that then delivering a gallery based programme - but this is quite an exciting time for us working with different partners and places and spaces than we normally would when we had a much, much smaller venue in Castle Park.

2. Can you briefly state what you do at folly?

I am the Programme Manager, I started being responsible for all the public facing aspects of our programme but that's another slightly different staffing structure. I look after what's called the f.present programme and that includes all of our exhibitions and things like film nights, etc. and festivals.

3. How did you think PBB would support folly's mission?

I came from an architecture, design and a visual arts background and essentially media arts practice was relatively new to me so I very much saw it as a way in which folly's remit could be expanded upon. I was aware that media arts practice was evolving itself particularly in terms of object based practice and device based practice and this seemed to be a perfect opportunity to actually enable folly to see that too. It wasn't necessarily seeing it automatically. It had a much defined view of media arts practice and I think at the time I was wanting folly to experience something slightly different. PBB enabled us to do that and I hope it has a lasting impact. Although I am aware that within our own organisation I might pick a piece of work from the show which I thought was really great and someone else might say that is one of the a poorest pieces of work. There is quite a bit of not confusion or contrast or contradictions there but I wanted folly to embrace particularly a design agenda that I thought was something that has been slightly lacking in media arts practice. You work with such cool tech invariably there is lots of cool design going on too and we are involved with various different projects related to design particularly our touch screen network project which is far more about network devices and the ability of network devices for tangible user interfaces and how they are designed is the

key element of that. It's not just about the content that gets deployed to those devices but the devices themselves are the content. PBB is going to set folly on an interesting road.

4. What did folly expect to get out of the exhibition?

It's very much seen as a catalyst and it was going to enable us to deliver a wider festival so it was seen as the anchor project (the Debenhams or Marks & Spencer of the shopping centre). We knew that we were going to have a critical mass of quality products which we could actually spin and produce some activity around it and produce a festival. It served a number of purposes in that respect. Even if we hadn't done the festival and we just had PBB it still would have been top notch and that was the way it was. We all contributed quite heavily to the success of PBB. Principally it was going to enable us to develop slightly larger although we couldn't foresee the scale because it was about development paths with annual festivals which we haven't done to date. So PBB was the anchor that enabled us to be involved with an interesting partner like Fast-uk in an academic perspective as well so you get much more of a grounding a much more rounded project.

5. How would you describe folly's role in the curatorial process for PBB?

I am pleased that we were equal partners and the discussions that we had about the selection of work and how the show fitted together was genuinely collaborative. The discussions we had were really quite interesting for me because it took in about scoring things and why you liked a particular piece of work and how did it fit, etc. I know there were some things that we said we would have liked to have but we didn't have that wouldn't fit in at all anywhere. I was pleased with what we had got the mix of fifteen or so pieces of work or fifteen participants came out of those discussions and that collaboration and that was very satisfying. It didn't feel like we were curating by committee it was coming out of informed discussion. There was a very clear goal and I thought that was great. Everything did hang together in that respect and that was the role from a curatorial perspective and it was interesting because there were different skills as well. From my particular background things were appealing to me in a different way. My colleagues in folly have a slightly different feeling

about some things. It never felt like a committee decision it always felt like we were having very vital discussions.

6. How useful was the fast/folly wiki?

It had its moments, it always helped particularly when we were thinking how the show might look the look and feel of the show to have things on a single page images that were either indicative or actual things that we were going to expect. To have that somewhere that we could all access and see, because there were obviously lots of people that we didn't work with, lots of people that we were thinking of inviting who never made it through for whatever reason. Even so part of that discussion that ability to actually formulate the show was helped by having it visually represented on a single page that you scrolled through it. I'm not a big fan of wikis personally but I knew that it did help in terms of communicating over distances to different partners and different parts of the country even though particularly in the look and feel the wiki was quite instrumental in helping us to formulate that far more than say, our meetings where we were looking at work.

7. What kind of practitioners did you expect to be in the exhibition?

I expected more architects to be in it and NIO as being in there was interesting and I kind of wanted there to be more architects, but I trained as an architect and I did think there was some interesting practice out there that we could have shown. I wasn't keen for us to go down the blobitecture route which is quite easy in many respects. I think that architecture now is slightly coming out of its blobby phase. I did expect more architecture I was looking forward to there being more spatial projects in there. The NIO piece that we got it took the PowerPoint presentation to try to explain to people exactly what was going on, but I would still have liked to see some designs for buildings not just designs for surfaces.

8. Was there anyone in the exhibition you were surprised by?

Probably Usman [Haque] and his team, looking back at it the proposal itself was quite a full proposal a very unspirited proposal as well and it was quite retentive in what it was suggesting. What we ended up getting was very flighty - not lightweight but a curious kind of frothy project which was quite at odds with the

original proposal which felt like a morgue - the original proposal felt like it was looking for dead people.

9. Did PBB support folly's mission?

Yes it did they enabled us to boost our profile in the time that we don't actually have a venue. Through work with the City Council on the redevelopment of the Storey Institute we had a direct contact with the development of the CityLab here in Dalton Square so I was able to pull a few strings and say can we have the whole ground floor. It works ok it's a curious building and actually getting people into that building, into the exhibition space was quite a challenge because we couldn't really do very much in the lobby and I would have been far happier if we could have energised that space too. But in terms of the actual exhibition, the physical manifestation of that provided us with a platform to reacquaint our existing audience with the work that we do because some people have quite a lot of difficulties with the work of folly. We were actually able to take people round the exhibition and they now understood the work of folly through the virtue of seeing PBB which bodes well.

10. Did the exhibition live up to your expectations?

I was very worried about the design of the show it was always very fundamental that the look and feel of PBB felt good. We weren't trying to fight a bland office environment we were actually trying to work with it. In many respects we tried to push it too far down the post-apocalyptic route particularly when it came to lighting. We were very pleased with the way we were able to light the show. It was done in an economical way and felt different as you moved through the show as well. At least those individual rooms had a different quality to them. It wasn't as if it was corporative light that we deployed for the entire thing. It was a concern that things would feel too much like a designer office but we took real virtue of the transparency that was available particularly in the first half of the show. Putting strong pieces in key anchor positions - there was three focuses to the show. With 'Cyclone.soc' as one, with the 'Morse' code piece in the middle and with the ['Holy Ghost'] chairs at the back they actually managed to space the show out quite nicely and detracted you from the fact that you were walking round a spec-office development. I think that the central spine obviously helped and our decision not to actually label things so people could view several pieces

of work at once using a shop window type fix. It was nice and that's unusual. In a gallery situation if you wanted to do that you would have to pay a fortune on plate glass partitions, etc. to create that look and feel so working with that was really important you couldn't ignore it you had to work with it and make the most of it. I liked the way that show felt and the way the show sounded. It was annoying to have the fire doors that were tied into the fire alarm system with electromagnetic catches. We had to put up lots of signs to encourage people to get right to the back.

11. Were you happy with the way the work was displayed?
Have addressed that.

12. What could have been done better?
We didn't energise the lobby or the façade of the building and I would have very much liked to see something happen there even Simon Husslein's clock could have could have possibly been in the lobby but the orientation of the staircase didn't necessarily make that the best idea. I would have liked to make more of a punch to start off with. It was too quiet there wasn't any sense of mystery or anything like that because we kept the show quite dark and I would have liked to introduce that element of mystery to start off with. There was that sort of notion that you weren't walking into an exhibition but that you were walking into some sort of laboratory. We could have played more of that up. If I could have changed anything I would have possibly tried to beef that up a little bit. It might have meant putting volunteers in white coats which you would have hated. We had the glory of being able to change the layout right up to the last moment which was a bit of a challenge because plinths were designed to go into particular places and there were only certain places where you could put them if you were going to move things around. So we were actually able to change stuff - it could have been a lot different and we could have been stuck with stuff being in certain places. The classic one was Simon Husslein's room because the light the piece cast created a very particular feeling which I really didn't like and this room has to share with something else and it took the magnetic pieces from Ben Woodeson to actually energise that space. Ben was an interesting one because he wanted to put those pieces everywhere and I think it wouldn't have worked. In terms of the two rooms we did put it in I think it worked particularly well, so

I think that we were very fortunate that we could change things right at the last moment. The only thing that I would have done differently was change the entry sequence. Our council partners were reluctant for us to do anything in that space, I still think that we could have a bigger splash on the front of the glass particularly if it had been a piece of work an artists work represented in that respect.

13. What would you do differently if you had the opportunity?

I think that what I would have wanted to do was again much as I refer to it being much like a laboratory, much more process evidence during the three weeks of the run. So some thing may change some things may have evolved. Lionel Dean's piece we expected there to be much more of a sense of evolution particularly in the animation. The animation I felt was disappointing because the objects themselves are incredibly beautiful and the animation dumbed it down and I would have liked to have worked with Lionel to have developed that animation in some respects to show how those tendrils and suckers were actually formed. I know it was a contentious point when Lionel was there and I had to take a step back and accept that this wasn't ideal but it was the process side of things. I wanted the process side of things to be evident in the show as a whole and that was one thing that could have been really great and really it wasn't. So if I was going to change anything I would like to think that certain works would have evolved in a way grow as a working practice taking place. It would have been wonderful to have had a machine a rapid prototyping machine or a CNC mill or something like that. The rooms themselves being glass encased rooms we could have easily had a workshop in there kept it dust free, people could have looked in the glass, easy-peasy, Although we didn't actually have that it was happening in the installation room because we had Justin Marshall doing the same thing. Would it have helped the show, would it have helped people's understanding of the show to have some process happening during the run? Even if Aoife Ludlow's piece, the interface of that works too fast over the course of a day it just became a big white mass. There was a process there but you needed to pull it out a bit more and we couldn't do that, we didn't get to work with the practitioners which I thought could have benefited certain pieces of work. Although I was quite happy with the look and feel of the show as a whole but we didn't automatically get the opportunity to work with the artists.

Some of them there were different dialogues there so 'What's Cooking Grandma?' was a very particular dialogue because they came to Lancaster to do their production etc. So the conversations were always ongoing. Other pieces we didn't know at all what they were going to be like until they arrived. Maybe that's not a bad thing maybe it's that element of process, by the time we got to the end of the run of the show I felt if this was folly Gallery now we would like to do is start introducing more pieces of work into this and take some of them away and start this shifting process where you get themes starting to build up and merge and pull away. After three weeks I was still very happy with the way things felt I didn't want to be shot of the show I felt that it could start to evolve with more processes being introduced.

14. In your opinion, what was the strongest work in the exhibition and why?

I was very happy with the overall quality of the show and I think that the works themselves all maintained a good level plane. In terms of the power of a piece of work I particularly liked the 'Morse' code installation in the middle. That spiral of plaster forms that for me was the fulcrum of the whole thing everything was spinning off that. I know when you get down to the basics of what that piece of work was about in terms of the off/on, zero-one, switches etc. which is all about the way that technology actually works. If you want to pull it down to basics it's just about dots and dashes. I like the way it felt, I liked the way the lighting conditions in there particularly it came through quite a busy space. To start of within the first part of the show you've got a quite quiet, reflective contemplative piece in the middle. I always liked coming into that space and I know that we spelt some aspects of it wrong or Justin spelt some aspects of it were wrong and it took a member of our audience to spot it. It became much stronger in the whole scheme of things because its placement or perhaps its spiral configuration which was something which came out of dialogue between the curatorial partners and the artists. I know that Justin wasn't the most convinced by that. I liked the way that worked I liked how that felt it had a decompression feeling to it. Other things felt different, there were different feelings to things and I just liked the way you could move around that it held its own and considering how it was originally supposed to be installed it wouldn't have registered on the Richter scale in terms of its impact. That was my favourite piece.

15. In your opinion, what was the weakest work in the exhibition and why?

There were some pieces that were disappointing because technically they didn't deliver what we expected. The 'Ibuki' object was a beautiful object but it didn't work the way that we thought it was going to work. I was disappointed about that - we worked very much with what we had it did get the most gorgeous plinth imaginable it was lit with a beautiful dappled light and the sounds it emitted were gorgeous. It just wasn't working the way that we thought it was going to work, you could always hear what it was doing, and you expect a silent object that resonated with your bone structure. You could hear it all the time and so I was a bit disappointed in that but still enjoyed resting my ear on it. It still had a nice feeling to it. We know its nothing compared to the giant 'Ibuki' object that we saw originally. Which we could have made quite easily for them here and I think that we should have pushed for that - to have made a large 'Ibuki' object because it would have held its own more. I'm not quite sure where we would have put it in the scheme of things. I do regret the fact that we should have pushed to reconstruct a UK 'Ibuki' object at its original scale and rope material and not the pebble that we got which was lovely and I'm pleased that we worked with those two artists but the original object would have been much more powerful. I still think that technically it still would not have worked right.

16. Were you surprised by any work in the show? Why?

I think possibly the 'Wi-Fi Camera Obscura' was the most surprising thing from an industrial design perspective I loved its eccentricity and wasn't really expecting that to be the case. I was pleased that we were able to make a second one and develop the relationship with the partners in the building, we actually had this split view. I don't know whether or not if the piece of work is actually doing anything really or how it really works. I know that one of our volunteers did come into us and say he'd found somewhere on-line with instructions of how to make a 'Wi-Fi Camera Obscura'. Those two things didn't really go together. That one did surprise me the most and when it arrived the industrial design element of it I found very satisfying. It had such a gorgeous sense of design as well so there use of a pink foam card, etc and the way that they were clustering things together. It had a home made quality to it they weren't trying to be the perfect of physical devices but everything was evident. Then our

decision to attach the computer to the wall the way we did we had two plasma screens running at the same time making everything evident enabled us to have that very processed piece of work.

17. Did you think the exhibition was coherent?

Yes I did taken as a whole I think it was a good snapshot of practice at this time. I think that maybe I expected the show to have more of the same types of pieces of work and less a selection box. I'm very pleased with the selection box that we got and the overall feeling that that had. I think that if I had seen room after room of rapid prototyped objects or room after room of blobby architecture it would not have been as satisfying a picture but we had enough contrast in there to still make everything gel and stick. It didn't feel homogenous that here were fifteen pieces of work by fifteen architects and you could swap all the labels round if you liked something else. What you got was a lot of work and a lot of personality.

18. How would you sum up the core theme of the exhibition?

I think that fundamentally it was a design show. I don't look at it as being a visual arts show or even potentially a media arts show. Design was the key - it had a strong quality of design to it and I think the technologies that we talk about enable this varied convergence of practice they've all come out of the design industry. Somewhere along the line they might have been fighter jets to start of with but it's fundamentally about design. Even for an artist to take that type of technology there are design sensibilities coming out of the work. Geoffrey Mann's piece was perhaps the most artistic of all of them because it had that one-off feeling about it. It didn't feel like you could push a button and produce another one although of course you could. I think overridingly it felt to me like a design show and I think that also reflects the fact that media arts practice is moving down a particular route in terms of object based practice, device based practice and because of that it's embracing much more to do with design.

19. What did you most like about the total exhibition?

It did have a spirit to it there wasn't anything fusty in there everything felt vital, alive and that had as much to do with the juxtaposition of works because some

things could have felt quite differently if they were put together in different ways. It felt contemporary it felt that there was actually some blood running through the work. You could quite easily go somewhere like the Tate and just feel that everything is dead. Actually it felt really alive.

20. What did you least like about the total exhibition?

Some of the restrictions in terms of movement I would have liked to have opened that up slightly - you had to work with the architecture of the building which meant that the last three rooms had the capacity to get a bit lost. If we weren't there our volunteers or folly staff had to encourage people to move through. We used that to create different types of spaces going through the show but having that kind of zig-zag feel to it automatically made the show slow but by putting the 'Morse' code piece right in the centre it felt that you were gathered around that. The architecture of the building was difficult to work with and it showed.

21. What feedback from the local community did folly receive about PBB?

We do have a good audience base and we were very consciously talking to all our visitors during the run and it was nice to find that people actually understand folly better because of this particular show. Some people had been wondering where we were, lots of people went to the show who went to our original site which was Castle Park thinking we would be there. So from our perspective it helped people to understand where folly is right now and where folly is going to go to next. Maybe it helped people to understand media arts practice which is a very, very difficult field to explain to anybody. It gave us a platform, we haven't disappeared. They were also saying it was also great for Lancaster to have such a high quality exhibition which traditionally would have gone to Manchester, Glasgow or London. I had to explain to people that there are very few venues in this country that could take a show like that because it doesn't fit in the within the traditional categories. Places like the ICA or the V&A in London for example some art galleries, like the Tate would shy away from a show like that so the fact that we were able to show it in Lancaster it was a show of quality and it was appreciated. People don't expect to see a show of that quality here which is

unfortunate that people feel that way. This is the level of quality we deliver it's on a par with what we want to do and will continue to do.

22. What feedback from peer organisations did folly receive about PBB?

folly didn't have the best track record in terms of working in partnership with local partners and what it enabled us to do was encourage people to see the work that we do. Some people were further involved in wider f.city festival activity and we could explain our work far better by having something we could take them to and enable them to interact with things and see things which we can't do currently where we are. That has enabled us to establish good new working relationships with people who now understand the quality of the work that we do and want to develop new projects with us. So the Festival of Digital Culture that PBB was part of will happen again later this year and we have been quite taken aback by how openly people have accepted a different type of festival again, but they understand now the qualities of the type of work we do through the twin virtues of PBB and the festival that surrounded it. That's great for us because it makes our job a lot easier and this is about establishing collaborative working practice as well. It's not just about you can host this project its actually we want to work to develop this project and obviously working with Fast-uk and developing the show from a curatorial perspective obviously helped folly to recognise that we can work in that way and we will continue to work in that way.

23. What feedback from funders did folly receive about PBB?

I'm not quite sure how the Arts Council really felt about PBB I didn't really get the chance to talk to their representative who came. So I can't really comment on what the Art Council felt. Overall in terms of PBB and f.city the Arts Council were very happy, but I haven't any specific feedback, that I'm aware of in relation to PBB and the type of work on show. Taylor [Nuttall] spoke to Will Carr at Arts Council England.

There isn't an arts officer within the Lancaster City Council - the people we worked with had far more to do with the regeneration side of things and they were thrilled. We had actually managed to energise a building. Putting that work in that building would enable them to let that building and it showed the

potential energy that could be created from those spaces. Now the ground floor which we used has now been let so the council are very happy about that. The council are very happy about that. The council themselves weren't the best of people to work with in terms of use of the spaces - they got a bit precious about things. We just had to be careful about that relationship with them.

24. Has folly made any new professional contacts because of this exhibition?

Obviously we have maintained contact with the artists - they were all very happy to have worked on this particular project. If opportunities arise for us to develop things with them in the future then we will do so. Geoffrey Mann has contributed work to our contact scheme which sees photographic and 3D renders of works going into Lancaster Castle particularly the Drugs Rehabilitation Unit. A picture of one of the original renderings from 'Flight – Take Off' has to be installed in Lancaster Castle in the next couple of weeks along side work from local photographers and international artists as well. That's a nice relationship we have with that particular artist. 'What's Cooking Grandma?' continues to be a project we promote and we will be developing a teacher's pack or some form of educational pack which is particularly for eleven to sixteen year olds which is a good target audience of people who might come along and start documenting their Grandmother's cooking. We have been conscious of and more likely to follow up with some of these people next year or later on this year. We are aware of developing a studio approach to our working practice so it's not just about developing one project. We would be quite happy to work with them again and it might be developing two or three projects at any particular time. They could come under the folly wing and studio approach which is interesting. We are working with such a wide variety of technologies but there is specific expertise there. Aoife Ludlow is working with RFID technology and we are quite keen to develop new projects and she is a good contact for us to work with. So it's enabled us to expand our network and have a nice easy open relationship with a number of practitioners now. We have an immediate awareness of what's happening in a much wider field than normally we would have. So that's good very productive for folly.

25. Has folly received any new opportunities because of this exhibition?

Not directly, we've had a number of requests for more information about certain projects. One of the artists whom we rejected for PBB asked us to be part of a show in Valencia in 2008 so they didn't take it too badly. Certain projects are not right for certain people but other projects will be the fact that some people didn't make it through the range for PBB still enabled us to develop a relationship with a wider group of people. Normally we would have done particularly now that we are developing projects for the future we are looking at a broader spectrum of practitioners who might be able to contribute to the success of a project. It's been tried and tested with PBB.

26. Has there been any impact on traffic to folly's website because of the exhibition?

I'm not really sure during the festival everything went off the scale, 'What's Cooking Grandma?' particularly in terms of downloads there. If I was honest the figures for the figures for the exhibition were disappointing and we have subsequently shown with certain types of projects in certain locations we can actually get a much higher daily footfall into a project. That's both online and in actual people which is good for us so if we are going to do anything different again there are certain things that we could have done from a marketing perspective to increase footfall.

27. Has being involved in PBB had any effect on what folly will do in the future?

Absolutely! Media art practice is ever evolving; ever expanding through virtue of doing this particular show it just broadened our horizons so much more. To be able to do that here in Lancaster rather than doing it by going to see a show in Berlin or San Jose was great because the team benefited from doing it. People loved being down at CityLab although there were lots of technical issues to do with the installations that were problematic it gave our new team structure for the first time a lot of us had direct interface with the public through virtue of the work front. That was very beneficial to us because it proves that the team that we have can and does work. Those ongoing opportunities don't happen very often. We don't have a space.

28. Has being involved in PBB had any effect on your thinking about creative disciplines?

When I first came to folly from working at the biennial in Liverpool where I had a very architectural hat on I was preaching architecture a lot in terms of ideas for programmes. I had my own perspective of media arts practice as quite limited and often I wasn't hitting the mark and by being involved in this show has enabled me to broaden my own personal perspective. I have always been aware of creating shows that bring together lots of different disciplines and lots of practitioners to create an overall look and feel. That's what we tried to do with PBB although it didn't feel like a heavy thematic show. It had lightness to it which I really liked. So I've benefited from having my eyes opened a little bit more. We worked on inviting certain people to make proposals and if anything we found that the more interesting work was coming out of the open call. I know that you worked quite hard at getting certain people to make proposals in the open call and that has influenced me in terms of how we are developing f.city for 2007. We will put out an open call for existing works. At the moment we are very much working on relationships and developing relationships with practitioners - that's the key influence, these are people that we want to work with. We are aware of their work we like their work and we would like to develop a project with them so we are working together in terms of developing a proposal rather than saying here's two grand what can you do for that which is where we may have gone wrong in some respects. That approach worked in different ways for different people and the relationships I maintained during the development phase were quite different from those four practitioners. One was very hands off, one was almost completely occupying our time, one was almost veiled in secrecy and then the other one were just complete chancers - we had to rein them in all the time they tried to fiddle the VAT and things like that. I'm conscious in the way it's influenced me by trying to develop a relationship with people I don't know. They feel confidant and happy and it's like they hold you in esteem to actually develop a good project and that's as much as providing people with good opportunities. The kind of opportunities that you provide people is not about what point in their career they are it's about providing a good quality of opportunity and helping them to understand that. Working on PBB has informed the way in which we introduced velocity which is the next

version of f.city to international practitioners - we knew it was very important to understand the look and feel now rather than later.

29. How did you find working with Fast-uk?

In the team at folly it was a bit like good cop bad cop because I seemed to get all the nice emails and other people said they got all the bad emails. I know that we had some difficulties on being on brand with PBB and the way that we were communicating it. We did agree on terms of how we were to describe the project and that did go awry because there was different people who were understanding the project in different ways. If I didn't do something well it was helping people to understand why we are doing this project, why we are working with Fas-uk and how we must describe the relationship which we have. I know that sometimes Fast-uk got top billing sometimes folly got top billing and it was things weren't referenced where they were and we had agreed what the terminology would be and that was the same terminology that we stuck on the outside of the building it was the terminology that I included in the invitations for f.city 2007 so I'm sorry that at some point sometimes that didn't happen and I know obviously producing the brochure wasn't the easiest thing for our marketing communications people and often things were agreed and set in stone, etc. And then quite frankly smashed by somebody else and then they didn't go on in a particular way. I really enjoyed working with Fast-uk it was very curious on particular days to get nice emails from you when one of my colleagues were getting the really nasty email from you. I thought how do I square this - something has gone wrong here and I wish that hadn't been the case. I think if we all understood the brand of the project and where it came from and kept those brands throughout it shouldn't have been a problem. A lot of it came from different sets of copy being applied to different sets of documents and there was a lack of consistency there. So if I failed in any particular way it was because the consistency was not maintained throughout. I was really thrilled from a curatorial perspective that we were able to work together and delivering the workshops and all the added value to it as well.

30. Would folly be interested in partnering on another show of this kind?

Of course and we did extend an invitation to you in terms of f.city 2007. If we do work together I like to think that it wouldn't be the same type of show it would be something different again. I think if we devised PBB as a touring show from the start I think that would have been interesting as well. I would like to think that what we do next is some form of touring project if it's going to be an exhibition. Obviously we are aware that Fast-uk other things which relate quite nicely with things that we do. I would like to think that the strength of the relationship would enable that to happen. Fast-uk is a very different organisation than folly it has capacity issues in terms of the work that it does but it does do very interesting projects. I do envisage that we will work together on something in the future but I think it should enable both of our organisations to grow in the way that PBB enabled folly to grow.