Traditional approaches using new technologies: Case studies of printed wallpaper using UV inkjet printing

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ABSTRACT  
The objective of the Wallpaper Project, in collaboration with Roland DG (UK) Ltd and with support from European Research Development Funding (ERDF), was to develop a range of printed materials and surfaces that could be developed as print on paper, textiles and applied to walls, which could be interactive with the user with a long term objective to adapt to changes in the environment. The paper explores contemporary approaches to wallpaper design that combines craft, design, cutting-edge fabrication and novel printing technologies. New printing technologies are now being used to print onto a range of materials (plastics, metal, wood, uncoated papers) and can be used to trial new inks and methods of printing (UV hardening, metallic colours, ceramic, three-dimensional, non standard colour).

Using the wallpapers created by MA Multi-disciplinary Printmaking students and research staff at Centre for Fine Print Research, University of the West of England, Bristol, this paper describes a series of case studies, and highlights a range of interesting opportunities and decision processes creative practitioners encountered when using new technologies.

The wallpaper project is part of a larger enquiry into 2D and 3D printing. The paper discusses the wider implications of a novel process and materials-led exploration that explores new UV printing, additive layer manufacturing and rapid prototyping.

Keywords  
Rapid prototyping, wallpaper, UV printing, inkjet printing

INTRODUCTION  
Understanding, developing and perfecting any skill can be complex and time consuming. In recent history, inkjet technology has become a ubiquitous process, and with the introduction of laser-cutting, three-dimensional fabrication, decorative printing technologies and adaptive materials, there is a wide range of creative opportunities now available to the designer. However, the artist still has need of a thorough knowledge and experience of technique, material, software and process, and moreover a refinement of skills through practice. They require a theoretical underpinning of a range of subjects, in design and composition, and opportunities to apply theory to real world environments. They also require specialist knowledge, for example an understanding of colour print terms, such as the difference between additive colour mixing (photography, monitors ie. Red Green Blue,) and subtractive colour mixing (printing ie. Cyan, Magenta, Yellow, Black). Therefore, the importance of developing new knowledge and skills in the digital field are still crucial.

The current market is mainly composed of two-dimensional printers, paper and vinyl printing, three-dimensional, computer aided design, aqueous and inkjet, solvent wideformat and ultra-violet (UV) printing onto paper, plastics and board. Based on current advances in printing and rapid prototyping there exists many opportunities for the development of printed colour-changing pigments onto unusual materials and the fabrication of novel three-dimensional objects. There are now opportunities for users to exchange and update ideas through forum-based networks on the Internet and to gain access to emerging ideas on cutting edge technology. Through open-source communities and by developing novel software and hardware technologies, there is the potential for crossovers between virtual to product concept to object.

However the technology is still expensive for the commercial printer and independent designer. Furthermore, hardware is designed with one function, which seems costly in terms of hardware and sustainability. Based on our experience, there are opportunities to address the needs of the user, to develop a joined-up technology, that is multi-functional and to consider the workflow between different applications and hardware. To address these issues, partnerships forged between the Centre for Fine Print Research (CFPR) and industry, have grown significantly over the last ten years. This growth has been due to the emerging need for industry to initiate commercial
enterprise into new markets. At the CFPR, collaborative projects between researchers and industry, that addresses the needs of the creative and the industrial sector has resulted in, for example, new industrial products, processes that assist the creative development of the artist, a range of samples that demonstrates the capabilities of a new product or process. The research seeks to contribute to the field of design-led-practice from the perspective of the creative industry and industrial-based manufacturing. In collaboration with industrial partners, research methods have evolved that addresses shortfalls in hardware and software capabilities; in some instances as beta testing of equipment prior to launch in the market. [1]

The objective for this research project[1] between creatives and industry was to analyse, from an empirical perspective, new inkjet printing methods and three-dimensional fabrication technologies; in this instance towards the production of printed wallpaper. The research was undertaken in collaboration with industrial partner Roland DG (UK) Ltd, which manufactures ultra-violet-curing (UV) and solvent-based inkjet printers for the poster, signage and packaging market. The project tested the recently introduced UV-curing solvent inkjet printer and cutter, the VersaUV LEC Series printer, which has the capabilities of printing full-colour images, opaque-white and multiple layers of gloss onto a variety of materials.

The backgrounds of the majority of the artists working on the wallpaper project are based in the fine arts, for example, printmaking, photography and ceramics. Although all of the fifteen artists were provided with the same brief: to design a pattern that would be suitable for printed wallpaper, and then printed using the capabilities of the Roland printer, the result was, that no two images, materials or methods were the same. We were therefore provided with an invaluable method for testing the limits of the technology (indeed to breaking). As each artist was faced with software, print workflow management, material choices, there evolved many restraints, discussions and reworking in order to ensure ideas were feasible and practicable. With all these other requirements, it was often considered that creativity was the last in the design process. A range of these issues: the impact on the creative process, the final outcome in the context of contemporary arts, and current trends, will be considered in the case studies.

PRINT ON DEMAND, ONLINE COMMUNITIES AND THE VIRTUAL CREATIVE

Access to industrial manufacturing techniques has for some time belonged to the large companies and research centres in universities, who have funding and skills available to invest in digital technologies such as wideformat printing and rapid prototyping. Now, due to a reduction in costs in the technology, small companies and designers have a greater opportunity to purchase hardware or gain access through on-line bureaus. These opportunities for access are not only altering the manufacturing process on a global scale but also stimulating ideas relating to mass customisation, on-demand manufacturing and desktop fabrication. And as there are increasing online communities working towards open-source knowledge exchange, these groups are transforming and challenging notions of creativity and print. Two-dimensional print-on-demand (POD) services have been widely established and are popular for reproducing fine art prints. The National Gallery London in collaboration with Hewlett Packard Labs, were an early protagonist of POD (2003). The Scientific Department within the NG conservation group and collaboration with University of Southampton, systematically captured high quality mega-pixel file images of their collection using a VASARI scanner [2]; the NG collaborated with Hewlett Packard Labs to develop a POD service that presented high quality, colour balanced reproductions of thousands of their works. This was initiated through the HP Art and Science Projects (2000) [3]. Other examples of recent applications into the customisation of digital print include photobook publishing (Blurb, BobBooks, Lulu, Snapfish) and magazine publishing (Magcloud). Artists are able to upload their images using book or magazine templates, publish online and print their works, even as little as a single copy, therefore making publishing economically viable. This has been very successful in appealing to a mass market wishing to publish their images, events and ideas. Since 2008, an international juried Photography Book Now award was launched by Blurb, which was open to their publishing community and has acquired an international profile.

During the last few years, print on demand has evolved into three dimensions. A number of Internet companies have been established such as Ponoko in New Zealand, and Freedom of Creation and Shapeways in Holland, which facilitate access to manufacturing technology and provide advice to independent artists. These companies have recognised the market potential for extending the creative opportunities for artists, and as a result, online communities exchange ideas methods, and suggestions for technology, materials and product finishes. By uploading their designs or adapting existing designs, the designer can specify the appropriate materials, can commission to have their work laser-cut or rapid prototyped, and then for the completed product to be delivered to their home. Thanks to this new found access, the global has become the local. As The Economist pointed out ‘A technological change so profound will reset the economics of manufacturing’ [4], thus creating a new industrial revolution. This on-demand manufacturing trend is changing the way in which consumers buy, and ultimately what they buy. The final printed product is no longer just a prototype, but a useful, working object.

Moving a step closer to at-home fabrication, the Internet has assisted in facilitating the DIY creative interests of home user, by enabling access to open-sourced projects,
such as RepRap, MakerBot and Fab@Home (figure 1). These sites allow the user to download all the information necessary to build their own rapid prototyping machine or ready to build kit. In theory, once built, the idea is that they can print whatever they want whenever they want, and, they can also upload their designs to online forums, therefore improving the user experience by sharing their ideas and selling the products. The New York Times has called the users of this trend as the ‘techno-hobbyist clan’. [5]

However, with any new and evolving process there are limitations. The author summarises: ‘The actual design programs are pretty easy for designers but harder for average people. And that remains one of the greatest limitations of 3D Printing. Artists with the desire to integrate this technology into their practice are experiencing a lack of working knowledge of for example, three-dimensional computer aided design (CAD) skills and file formats. Due to the slow ongoing integration into education and the high cost of such equipment and materials, artists do not easily have the opportunity to learn to build three-dimensional artefacts. This is creating a knowledge gap between artists and designers, and engineers and employers, and is a growing educational sector that needs to be addressed. By integrating contextualised study and taught courses in new technologies and CAD into the educational curriculum will enable students to explore the requirements in relation to the evolving market. They will be able to understand the potential of this technology in a real world practical context. Furthermore by creating stronger links with industry, students will not only gain more experience, but will gain the practical skills required to ensure their more competitive standing in the workplace.

RECENT DEVELOPMENTS IN INKJET PRINTING
Manufacturers of solvent inks are now incorporating decorative inks such as white, gloss and metallic (Roland, HP Scitex, Durst). Although white has always been a necessary component of any artists’ palette, inkjet manufacturers have been slow on the uptake. This is mainly because particulate sizes are larger in order to obtain the right degree of opacity when printed. However there is a tendency for these pigments to drop to the bottom of the cartridge, and therefore require regular agitation in order to maintain a uniform dispersion of ink. The inks are solvent or eco solvent (low-solvent) based. The printers are primarily designed as pre-press machines for the packaging industry and inks are cured by ultra-violet light.

The main difference between conventional aqueous inks and UV curable inks is the addition of photoinitiators. In UV inks, the photoinitiator is combined with liquid monomers (light-weight molecules that bind together to form polymers), and when exposed to ultraviolet light, release free radicals (reactive molecules that can start rapid chain reactions). These produce polymers (high molecules), which results in a resinous printed material. A UV printed surface tends to be more robust, scratch resistant and can be applied to a wider range of materials (cardboard, plastic, metal, canvas), than conventional inks, which are reliant on the coating of the paper to hold ink on the surface without it sinking into the fibres of the paper.

White can be used in a variety of ways, which is determined by the layout software, as a series of commands and then processed through the RIP (Raster Image Processor). The white ink can be used as an undercoat to print vibrant images onto clear, coloured or metallic surfaces. It can be used as a single spot colour to provide highlights, for example on a dark material. In the same way clear inks are used as a single gloss, as a varnish to enhance areas, or to create a raised surface by overprinting layers of clear ink. Metallic inks (Roland) are a new introduction, where a silver base layer is printed with CMYK spot colours to create a wide range of metallic colours. More recently Epson has introduced an UltraChrome HDR Ink with white, which is an aqueous-based ink, suitable as an inkjet proof print using an Epson designed proofing machine.

Currently we are moving from two-dimensional printed colour to three-dimensional printed colour. As printer hardware is becoming more versatile there is the potential to print with a much wider range of materials: from chocolate to ceramic. Three-dimensional printing technologies are increasingly being exploited by a wider range of practitioners in the creative arts and design, for example, www.freedomofcreation.com. Through new open-source three-dimensional printing and prototyping such as RepRap (replicating rapid prototyper), there are new initiatives to print components for printers, three-dimensional artefacts and objects that can be printed in situ without the need for mass production or transportation.

Fig. 1. Thing O Matic 3D Printer Kit, MakerBot – Cost £1049.00
These advances in rapid prototyping technologies have led to the emergence of three-dimensional printing, which can fabricate physical artefacts, including the application of surface colours. In three-dimensional printing, physical objects are “built” directly from computer modelling software. Three-dimensional printed objects are fabricated by layering powder based materials or liquid resins one on top of another [6] each layer corresponding to the cross-sectional shape of the object being built. Developments in this field have led to three-dimensional printing technologies being more widely available and affordable [7, 8] making them accessible to a wider range of users than earlier rapid prototyping systems which were aimed principally at industrial design and engineering applications. In powder-binder three-dimensional printing, layers of plaster powder are bonded together by a liquid glue binder, which is printed onto a bed of powder using an inkjet print head. “Full colour” three-dimensional printing is made possible through the inclusion of coloured dyes within the liquid binder solution (figure 2). [6]

These cheaper, if not cruder, self-replicating machines such as the RepRap, Thing-O-Matic from MakerBot (figure 1), allow the user a level of design control and production process; using a range of materials with the opportunity for creative experimentation. The possibility to expand into new and innovative areas of design, with the accessibility of these machines and materials, is potentially transformational. Innovation and experimentation has become accessible and freer to all.

Developing novel materials and applying them to every day items is evolving quickly. Yet these revolutions are not new: as new ideas are inspired by new technologies and manufacturing there evolves a symbiotic relationship between materials and technology, and a process of refining, comparison and redefining takes place, resulting in new benchmarks for quality. [9] Furthermore, the origins of Modernist movement of the 20th century and how we understand technologies today are rooted in the Industrial Revolution, which according to Gilbert Herbert in The Synthetics of Vision by Walter Gropius [10] ‘wrought havoc with established standards of design.’ Yet what were the novel processes and materials of the previous century are now considered as ubiquitous. This will be explored further at the end of this paper under Discussion.

THE WALLPAPER PROJECT
The objective of the Wallpaper Project, in collaboration with Roland DG (UK) was to develop a range of printed materials and surfaces that could be developed as print on paper, textiles and applied to walls that would evolve to be interactive with the viewer, for example, moveable parts, or removable stickers, sections that can be folded to conform to different structures, contain embedded lighting, change colour or surface appearance. The long-term vision is to address how we currently design, think and construct the materials in our environment; to operate a human-centred approach to the development of technologies, which allows us to imagine, design and create materials, surfaces, textures in a way that benefits human wellbeing and to design tools and materials that enhance our environment.

Set-up of the project
The remit for the artists was to create a wallpaper design that firstly reflected their own practice but also would test a range of materials and printing techniques. It was not necessary to design a traditional wallpaper composition, such as a repeat pattern, but could involve more innovative approaches to surface design, pattern and materials. The finished wallpaper might include a range of materials or combine hand-drawn elements with photographic, vector, cut lines and embossed surfaces.

The case studies highlight: firstly, the different backgrounds of the artists, how the resulting images for the wallpaper have evolved, the artists’ interest in materials, the relationship between the printed surface and the material; secondly, the relationship between craft (learning a new process, such as, software, colour, digital print) and the final piece; and lastly to consider wallpaper as a dynamic surface, that users can manipulate through, for example, adding stickers, changing through folding, or adding different modules, by activating through movement.

The participants were shown how to create and layout patterns in Adobe InDesign and Illustrator software; each software can incorporate bitmapped images, vector lines, cut-paths, colour blends and spot colours. The participants were also shown how to export files so that all the command printing features would be recognised by the Roland VersaWorks printer driver software. The Roland LEC series printer/cutter supports CMYK + white and clear ink configurations. The white ink can be used as an undercoat to print vibrant images on clear or metallic substrates. The clear ink can be used as a gloss or matte spot varnish for highlights or for simulating embossing.

Fig. 2. Coloured, three-dimensional sculptural objects printed using a Z Corp 3D printing system, by Peter Walters (CFPR).
effects by overprinting multiple layers of ink. These special printing features are accomplished by using specific spot colours in the design (figure 3).

![Swatch Options](image)

**Fig. 3.** Special printing features are accomplished by specific spot colours that are exported and embedded in the EPS or PDF files.

These spot colours have specific swatch colour names that when exported as an EPS (encapsulated postscript) or PDF (portable document format) from the Adobe design software are recognised by the VersaWorks printer software driver. A job can be saved into several files, each having different components of artwork enabled. The first file may contain the white and colour data and the second file may contain the clear and the cut-path data.

**Colour fidelity and colour management**

In order to achieve accurate colour when using aqueous-based inkjet printers, each paper and printer combination requires characterisation: calibration, paper linearisation and paper profiling. Due to the need that every paper requires a profile paper profiles need to be managed and updated. If a generic paper profile is used then this can result in a reduced colour gamut or poor colour rendering. This has caused many colour management problems for users in achieving accurate and consistent colour reproduction [11, 12].

UV printers require only a few paper profiles; the reason is that the polymer-based ink does not rely on the composition (cellulose, cotton, vinyl, foil), texture (rough, smooth, gloss, matt), the brightness (optical brighteners, natural) or colour properties (newsprint, off-white, cream, metallic, body colour eg red, blue, black) of the substrate. If, for example, the substrate is a dark blue then a white layer can be added to improve the saturation and brightness of a light colour upon a dark colour.

Using the UV printer, colours can be built-up using a layers function: chroma and saturation can be increased through the RIP software by selecting between 1 and 10 passes. This means that a light red can be printed but a red with a greater opacity and higher chroma can be printed using the same colour channel. However in order to estimate the final appearance of a multi-pass image and soft-preview on screen then an .icc colour profile needs to be created.

This was undertaken by printing a ECI2002V CMYK colour chart, which was then measured using a Gretag Macbeth Spectrolino with UV filter, standard illuminant of D50 and 2º colorimetric observer. An .icc profile was then generated from the measurement data and imported into the system software libraries. These profiles can then be used in any imaging application, for example Adobe Illustrator, InDesign and Photoshop. In order to soft preview an image in Photoshop using a profile, the following procedure was employed: View, Proof Set-up, Custom, then select “name of profile”, with preserve CMYK numbers and preview buttons checked (figure 4). This method of multi-pass printing was used for the work of Salaman and Barnes.

![Custom Proof Condition](image)

**Fig. 4.** (top) The dialogue box in Photoshop showing the custom proof profile. (bottom) A soft preview demonstrating the difference to printed colour using 1 pass (left) and 5 passes (right).

**A description of the case studies**

The following section describes five case studies from a group of fifteen invited artists. Each artist has explored their ideas using very different materials and effects. Each had quite specific requirements and objectives but did not quite know what to expect in the final result. A process of trial and error, an empirical approach, was the most interesting part of the exploration: by generating images, trialling with gloss, white and cut-paths, and exploring the relationship of idea, image, print and material. Each artist had no experience or expectation as to how the finished image would appear. However, now that each has devised their own unique method, they can now continue to develop new images using their bespoke process.

**Luke Salaman**

**Wallpaper title:** Stress Patterns

**Keywords:** interference patterns, iridescence, polarizing film, layers, colour

Luke Salaman’s recent work centred on creating imagery that investigated our conflicted relationship with oil: direct imagery of refineries, tankers and plastics produced from petrochemicals contrasting with the striking rainbow interference patterns caused by oil slicks on water. The colours that appear from petroleum on water are similar to the iridescence of butterfly wings. Initial print tests were made on shiny plastics, but when trying to achieve an
iridescent quality to the images, he realized that he could not get a truly iridescent effect using inkjet technology.

Fig. 5. Luke Salaman. Stress Patterns

As part of his research, he tried Smartfilm (also referred to as Chameleon film), this is a micro-thickness polyester film, consisting of no less than 250 layers, which are extruded to obtain a very thin film. It demonstrates the optical property of ‘colour switching, which when applied to a light surface the film spectrum ranges from a violet-blue to a pinkish red; on a darker surface, it turns from purple to gold. This optical surface resulted in a change of colour as one moved in front; it also opened up the possibility of using a black and white image under the smart film that would optically interact with the film above it.

Experimenting further with the optical properties of the Smartfilm he then generated imagery based on the physical characteristics of thin-film plastics when subjected to stress. The process involved stretching cling-film, placing it between layers of polarizing film and scanning at high resolution; the polarizing film enabled one to see the stress patterns in the plastic, resulting in an image comprising a vibrant spectrum of colours. The initial test prints onto Smartfilm using the Roland printers were promising and worked well on the film.

Using the Roland printer, the wallpaper comprised a series of printed and bonded layers: a black and white backing layer, a micro layer of Smartfilm, then a print of the polarised image on top. The high contrast, black and white images worked best under the Smartfilm, as this activated the colour switching most effectively and could enable the image to be seen from acute angles. As a viewer moves in front of the wallpaper panel, the colours change from a violet-blue to a pinkish red and on the darker surface, it turns from purple to gold; thus creating a constantly changing display.

Luke felt that the project had been enjoyable and challenging. He explained that the process evolved unexpectedly from the tests, which enabled him to create a much more visually and optically complex wallpaper than expected. It had also been interesting to work with industrial technology by seeing how repurposing this print technology could extend visual possibilities within an arts context.

Gemma Wright
Wallpaper title: Reichstag Repeat
Keywords: experience, interaction, self-assembly, layering, installation

Fig. 6. Gemma Wright. Reichstag Repeat

The primary concepts behind her wallpaper design were experience, interaction and self-assembly. The viewer would be given the opportunity to add their own design input onto the finished wall through adjustments and rearranging the placement of decals and layering of different printed sections.

There were three components to the wallpaper design: a series of large vinyl decals, a translucent paper printed in a subtle white, and the main wallpaper design which was printed in grey with a gloss overlay. The decals could be applied directly to the wall, with the paper sections overlaid. This design would also transfer well into blinds and screens with transmissive light enhancing the gloss printed elements.

As a silkscreen printer and constructivist she works largely with three-dimensional printed-paper forms, encouraging interaction between the viewer and the object through touch and movement. Her imagery for this project was derived from patterns within architecture and this design depicted the Reichstag Dome in Berlin as a repeat. The objective was to work with the range of capabilities of the Roland printers and integrate them into her practice alongside more traditional printing methods and techniques. Gemma was particularly interested in the gloss printing and cut contour layers, which came about through testing a range of different papers. The addition of the gloss to the lightweight paper (40gsm) rendered the gloss printed areas as semi-translucent. As the strips of paper were held up to the light there was an interesting interplay between opacity and translucency. The final result came about through
chance layering and the over-layering of different opacities of paper.

**Sophie Adams-Foster**  
**Title:** Structural interventions  
**Keywords:** architecture, constructivism, form, line, material

Fig. 7. Sophie Adams-Foster. A printed, cut and folded panel is placed in front of another. The semi-translucency of the material allows for sub-printed layers to appear.

Sophie’s work explores the forms found when moving into and around architectural structures, as represented by folds, cuts, lines and print. The inspiration for this piece was the Berlin modernist architecture, in particular The Fernsehturm (TV Tower) in Alexanderplatz, and relates to Sophie’s interest in Constructivism, architectural forms, print and photography.

Using the material characteristics of Folex (also known as Mark-Resist, both are a grained polypropylene plastic that is used as a photopositive in screenprinting) such as its semi-opaque quality, ability to hold folds and interesting aesthetic value with gloss was key in the development of this idea. By creating moveable wall panels with the potential to layer, the objective was to enable the user to create their own three-dimensional wall arrangements that could also be used to hide unsightly features such as pipes or cables.

Having developed previous works using laser-cutting technologies, Sophie was especially interested in the opportunity to cut and print simultaneously without the need for calibration. Drawing on existing Illustrator skills to create complex designs was very important, but the knowledge and understanding of the software used in conjunction with this particular printer was a challenge. When starting to create the design it would be been advantageous to know how to prioritise cut or print lines, which may have altered the methodology. As Sophie suggested, “through trial and error I began to understand the relationship of the design process and how it related to the printer software and the subsequent shortfalls of the printer. As with any new learning process, given time and practice, techniques such as these will become an intuitive knowledge and ultimately alter the final outcome of my work.”. Moreover, during the developmental stages, extensive testing was made into determining the relationship of the thickness and flexibility of the material, to ensure there was sufficient rigidity of the panels after it had been cut and folded.

**Sarah Barnes**  
**Title of wallpaper:** Triangular  
**Keywords:** colour, print, three-dimensions, experience, interaction, layering, apertures

Fig. 8. Sarah Barnes. Laser-cut triangles in combination with printed panels.

In her design, Sarah Barnes explored the theme of architecture and the urban environment. She was interested in how wall coverings in particular could enhance the way we interact with the spaces around us. She considers the element of interaction as very important within her practice and was intrigued by the ways this could be achieved using wallpaper. As a result, she investigated how interactive, three-dimensional, coloured and layered elements could be incorporated in the design. The wallpaper was designed in Illustrator and comprised three layers that were printed onto two different weights of paper:

The first paper, a light-weight laid paper, was printed on both sides, using a mint-green colour on the top side, with a gradient colour of purple to pink on the underside. Laser cutting was used on the first layer to cut and engrave small triangular flaps as an interactive and three-dimensional element. The second, using a heavier weight paper, was printed with a geometric triangular design in grey and purple. This was placed underneath the first paper. Through the unfolding of the triangular flaps the user could interact with the design, revealing not only the printed pattern beneath but also the gradient colour on the underside of the triangles. The number of triangles that could be folded back was based on the individual’s choice, allowing the wallpaper to be unique. These unfolded elements provided a tactile, textured and very multi-
dimensional wall-covering solution, which changed in appearance as one passed in front and the light was reflected at different angles.

The initial objective was to print and cut the paper using the Roland printer/cutter. The printed results were excellent, producing a rich density of colour. However the printer cutting-tool was unable to obtain a clean cut into the cotton-based paper, resulting in tears and white edges. Despite putting it through the printer twice, the cut lines were not consistent and deep enough. We decided therefore to laser-cut the wallpaper, which achieved a precision cut.

Sarah is keen to develop her practice by utilising new technologies, so having the chance to explore her design ideas with the Roland Printer was invaluable, and is an area she would like to continue to investigate in the future.

**Carinna Parraman**

Title of wallpaper: Spiral-graph

Keywords: three-dimensional stereo printing, new materials, Guilloché, lenticular patterns, illumination

**DISCUSSION**

All creative practitioners will encounter new processes, materials and opportunities as part of their exploration of their practice. Whether the techniques and materials are old or new, these have been revisited, revised and exploited time and time again by artists and designers. As described in the earlier sections, the process of searching and redefining materials and process is not new. The following section provides some examples of designers who have been inspired by other sectors of the industry.

**The traditional maker working with new technologies**

The Wassily Chair - a tubular steel chair – designed by Marcel Breuer in 1925, is an interesting example of, what was at that time, the use of industrial materials and novel manufacturing techniques. Predominately a manufacturing material that was known for its functionality rather than for its form, Breuer’s design was revolutionary and still sets contemporary precedents in simplicity of design and function. Other materials, such as formed plywood were also of interest to Breuer, who during the 1930s worked at Isokon, [14] a London based company known for modernist architecture and furniture.

Although plywood was already being used in furniture design and construction, a more flexible and durable material evolved as a result of developments in the aviation industry during the Second World War into methods using heat forming. Breuer’s most notable product was the Long Chair, which is still being produced to the exact
specification at the Isokon Company in Chiswick. Both of his designs revolutionised not only the way in which designers approached design and the types of methods of production, and lastly, new products for consumers.

Fig. 10. Windmill Furniture Company, Isokon - Mould for Long Chair, plywood in glue & mould stages (2009)

Some designers and creatives may doubt the integration of new methods such as rapid prototyping, yet it appears that many designers are welcoming the digital age. Dirk van der Kooij (figure 11) and Joris Laarman (figure 12) are two designers integrating new processes and ideas to produce beautiful and functional everyday artefacts.

Fig. 11. Dirk van der Kooij – Endless Chair, from a continuous string of plastic.

Kooij recycles old plastic into a chair from a single continuous string using a ‘robot’, which is not dissimilar to a large-scale rapid prototyper/injection moulder. As well as incorporating sustainability into his designs, the process also allows for the potential for individual customisation.

Working with the company RoboFold based in the UK [15], Joris Laarman uses the new technique of ‘rapid manufacturing with sheet materials’. [16] Using 6-axis industrial robots and a pre-scored sheet of material, the robots then fold and construct the sheet into a new shape (figure 12).

Fig. 12. Joris Laarman - Folded Chair, formed from a sheet of metal made by robots.

Just like Breuer and many other designers, Kooij, Laarman and Robofold are challenging perceptions in manufacturing techniques and consumerism. Designers are embracing the new digital age and the opportunities it offers.

**Truth to materials**

To date digital fabrication technologies have been developed for a very particular function, for example, modelling a component for car, or as a proof-of-concept model. As artists and creative practitioners have recognised the creative potential, two-dimensional and three-dimensional digital fabrication processes have been adopted through experimental and creative routes, resulting in modifications and reconstruction. Artists are creating new cross-breeds in practice. Yet the value that these processes command is still debated amongst arts practitioners.

Traditionally it was believed that the craft and construction of an artefact should relate to the material. [17] This theory could be considered as in conflict with the use of new technologies and what is perceived to be manufactured items through virtual design systems. If an art object is known to be rapid prototyped rather than handcrafted, even if it has the same qualities and characteristics, does this make it less of an ‘art object’?

Peter Dormer, in the context of new technologies in *The Art of The Maker*, states that ‘technology brings life’s comforts, but we look to the artist to provide human drama’. [18] He continues further that ‘the process is a part of the meaning of the work and our recognition and contemplation of its presence’. [19] Many will acknowledge that it is the knowing and understanding of how an object has been produced, the subtle changes and even mistakes that are made, that bestow upon an object its value and integrity. On the other hand, design and production through rapid prototyping allows for the refinement of detail, and the
creation of multiples, but does it therefore lose its individuality?

The artists working on the Wallpaper Project at the CFPR have been drawing on their experience to create work that directly relates to their own practice. They have incorporated their own ‘tacit-knowledge’ [20] and adapted ideas and process to suit the technology. These artists could argue that their work is individual regardless of the opportunity to create multiples. This is where technologies are being altered to create new crafts.

FUTURE OPPORTUNITIES

There are also opportunities to incorporate colour-less materials, light storing and emitting, chemical changing materials, liquid crystal pigments, solar and thermal changing inks that will respond to the changes in light and temperature or are activated as the viewer moves, thus creating a dynamic environment. By incorporating good design, there is a potential to reduce the need to replace, for example, wall decoration or textiles, which will have more sustainable benefits in the future. Over the last decade there has been discussion of how technological advances and devices such as mobile devices, e-paper, and transmissive material can be applied. A recent article positioned our current situation: “If the past 10 years have been about post-institutional social models on the Web, then the next 10 years will be about applying them to the real world. The story is about the next 10 years.”. [21]

Future questions include: how can existing hardware be adapted to create multifunctional printers and cutters using sustainable materials? By using paper based materials and cutting technologies, an important objective is to increase market awareness beyond its current industrial profile, via for example, wall decoration or textiles, which will have more sustainable benefits in the future. Over the last decade there has been discussion of how technological advances and devices such as mobile devices, e-paper, and transmissive materials can be applied. A recent article positioned our current situation: “If the past 10 years have been about post-institutional social models on the Web, then the next 10 years will be about applying them to the real world. The story is about the next 10 years.”. [21]

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