autonomatic

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Foreword

The 3D Digital Production research cluster at University College Falmouth set out on its expedition to further the boundaries of digital making in October 2003. Bringing together a group of practitioner-researchers with established skills in digital designing and making, the cluster aims to contribute innovative developments in design products and processes.

With established craft skills in ceramics, glass, plaster, metals and textiles, researchers approach digital technologies in diverse and creative ways: combining the autonomous approach of the maker with the flexible production capabilities of automated digital manufacturing. Through this research they are challenging boundaries between hand and machine, craft and industry, and are developing a hybrid autonomatic design methodology.

Within the Crafts there is an ongoing argument that the use of hand tools provides evidence of real human skill and that the use of machines can only cause a loss in the richness and complexity associated with individual human expression. Alongside this critical debate, Computer Aided Design and Computer Aided Manufacturing perhaps continue to be perceived as inaccessible, overly technical and inappropriate for the freedom of expression desired by both new and established makers. In practical terms CAD/CAM relies on a mathematical rather than an intuitive approach and getting to grips with these new tools in an effective way requires a significant and ongoing commitment in time alongside open access to experimentation with technology.

It is widely understood that digital technologies are capable of reversing the usual economies of scale and dismantling traditional supply chains. As with desktop publishing – which transformed the graphic design, print and photography sectors – the emergence of affordable digital manufacturing heralds an era of customisation and responsive localised production, even in the home-territories previously occupied by craft production. It is important in this digital era that handskills and individual expressive forms should continue to be re-evaluated.

This booklet presents research that demonstrates the potential for individual creative expression developed through the integration of digital technologies into making practices. It also begins to demonstrate how digital makers can bring their products and ideas into wider contexts: to engage in a spectrum of manufacturing methods, from micro to macro; to be more flexible in relation to their client's needs; to communicate and collaborate with other design professionals, manufacturers and design users; to diversify their range of design products; and most importantly to create innovative design.

There are great possibilities for further research that combines this creative, integrated approach with the expertise of engineers, technologists, economists, and manufacturers. It is perhaps the high level of human engagement with materials and technologies involved in the process of designing and making which places makers in a unique position to contribute to the development of human oriented and individually customized design production.

Appropriate dissemination is key in practice-based design research and the cluster uses multiple methods to reach other design researchers, professionals and students, including exhibitions, hands on workshops, international conferences, symposia, live projects and publications. Wherever possible research findings are tested and developed through to their practical application in producing design and craftwork that can stand alone in professional contexts – thereby reaching the necessary levels of credibility for peer review.

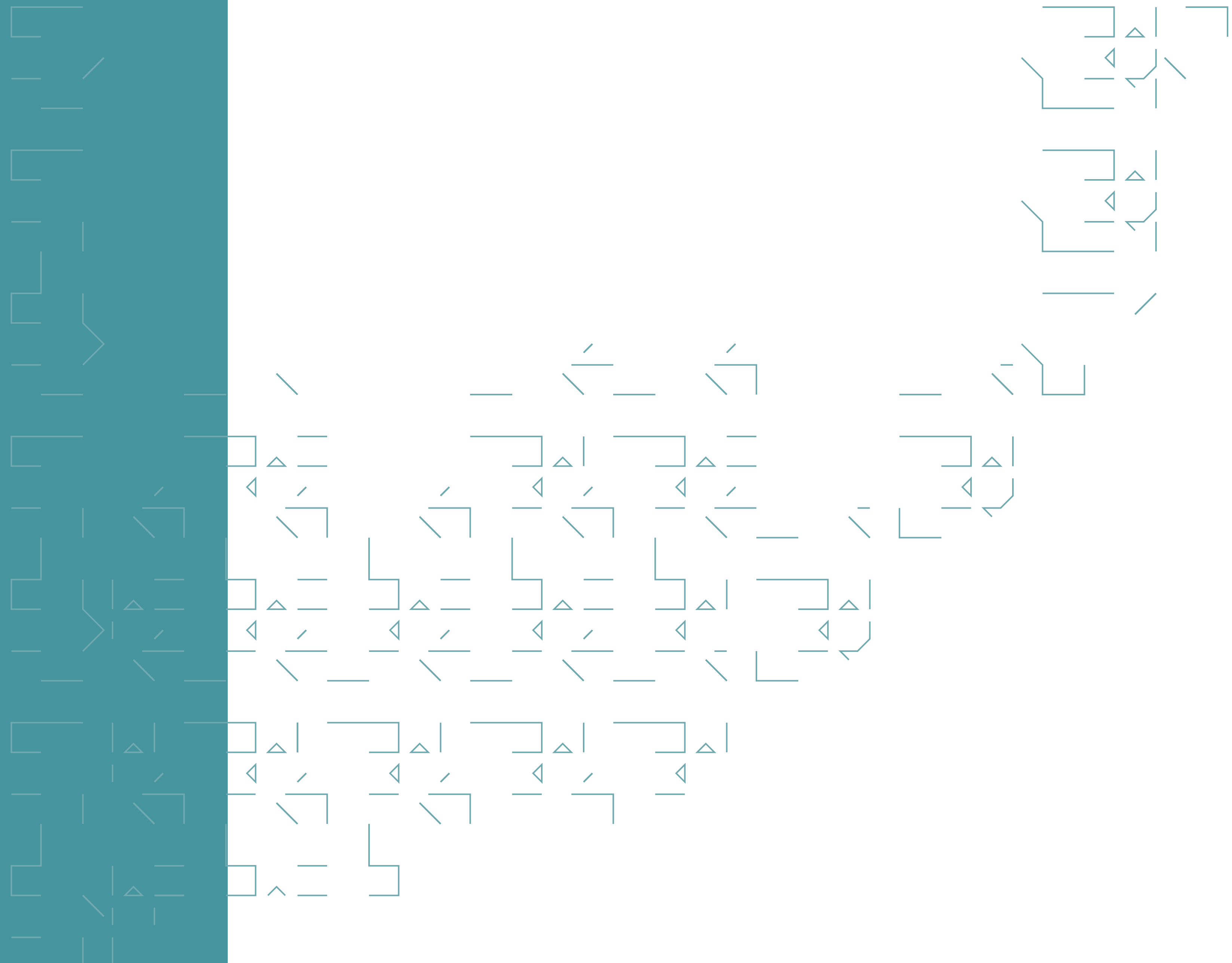
The potential impact of bringing hand craft and digital technologies together goes beyond the realm of current craft practice and is significant in global design cultures. Given its high proportion of makers spread across a wide area, Cornwall provides a unique and appropriate context in which to develop digital craft practices and the research cluster plays an important role in widening participation in opportunities offered by Higher Education institutions.The cluster works with makers in Cornwall through forums, practical demonstrations and live projects.

Digital craft processes have been in development from as early as the 1980's. However there is still a great distance to travel in order to make them more accessible and appealing to makers. Through continuing support for research in this field we will begin to fully realise the potential of integrating autonomy and automation.

Professor Eric Spiller
Vice Principal, University College Falmouth

autonomatic

lesley jackson



The word Autonomatic sounds vaguely familiar, yet it doesn't appear in the Oxford English Dictionary.

It is a hybrid fabricated from two other words: Automatic, defined as 'mechanical' and 'working of itself without direct human actuation'; and the less familiar Autonomic, derived from autonomy, alluding to personal freedom and self-government. As such, it carries within it an intrinsic contradiction: Automatic suggests involuntary, repetitive, machine-like or machine-led actions; while Autonomic implies human self-sufficiency, independence and individuality.

The question is, how can these two opposing forces or instincts co-exist? This conundrum lies at the heart of the 3D Digital Design Research Cluster at University College Falmouth (UCF) – a group of designer-makers whose raison d'être is to explore and extend the applications of digital design and manufacturing technologies – who have co-opted Autonomatic as their collective nom-de-plume.

If you type Autonomatic into a Microsoft document, a red wiggly line materialises underneath, indicating a spelling mistake. Google is also rather flummoxed. Do you mean Autonomic it queries? The primary application for the word Autonomic is in human biology, specifically the Autonomic Nervous System. The ANS sends vital messages from the Central Nervous System to outlying organs instructing them how to react: altering the heart rate, for example; or prompting the secretion of enzymes in the stomach. This all happens automatically – in other words, autonomically – without us consciously activating these responses.

Interestingly, in recent years the term Autonomic has also been co-opted by the computer industry. Part of IBM's current research is focused on Autonomic Computing: self-managing computer networks that adapt to changing circumstances and sort out problems for themselves, rather than relying on human intervention. On their website, IBM cite the Autonomic Nervous System as the inspiration for their research: 'The implications for computing are immediately evident; a network of organized, "smart" computing components that give us what we need, when we need it, without a conscious mental or even physical effort.'[1]

It was Dr Katie Bunnell, a ceramic designer with a long-standing interest in computer-aided design and manufacturing (CAD/CAM), who came up with the name Autonomatic for the 3D Digital Design Research Cluster at UCF. As Cluster Leader, Bunnell heads a small team of multi-disciplinary designers based at the newly built state-of-the-art Design Centre at UCF's Tremough Campus in Penryn. The other members of the group are Dr Justin Marshall and Tavs Jørgensen (both Research Fellows) and Drummond Masterton (Research Assistant). It is interesting to note that Autonomatic share some of IBM's aims, notably their desire to humanise new technology. Basically, their mission is to demystify digital technology and to promote its wider take-up amongst designer-makers of all persuasions (rather than a technically-minded, engineering-orientated few) as an aid to creative independence and autonomy.

'The digital manufacturing technologies we use, developed through science and engineering research, have until recently been relatively inaccessible to individual creative practitioners,' state the group on their website. 'Their use as an integral element in small scale production opens up opportunities for micro design businesses to operate in wider design fields.'[2] Through their individual practice-based research projects the four designer-researchers in Autonomatic explore ways in which 'anonymous' digital technology can be 'personalised'. Whilst drawing on their extensive practical hands-on knowledge of materials and techniques, their aim is to investigate how digital design and manufacturing processes can be incorporated into contemporary craft and design in a positive and liberating way.

Although they do not offer a definitive explanation of the term Autonomatic, in setting out their collective aspirations, they float various ideas as to how it might be interpreted: 'Through our individualistic and autonomous approach to using digital technologies, we hope to inspire other designers and makers to approach digital technologies with a creative mindset.'[3] The key words here are 'individualistic', 'autonomous' and 'creative'. Tavs Jørgensen, who originally trained as an artisan potter in a traditional craft pottery in Denmark, elaborates further. 'Autonomy is the defining characteristic of the craftsperson,' he declares.[4] By autonomy, he means the independent artistic vision of a single individual, something unique to that person. 'The new technology offers equal, if not greater opportunity for individualism,' he believes. 'Far from using computers to automate craft skills, the vision for the future should be to develop traditional craft skills in conjunction with the new creative opportunities.'[5]

Autonomatic are not a design team in the conventional sense, although they are united by common interests and they share skills, knowledge, facilities and experience. Each individual within the research cluster has their own distinct areas of activity, their own particular methodology, their own personal creative agenda and, as a result, their own unique identity. Diversity is their greatest asset and the key to their collective success. Their applied research shows how positive digital media can be as a spur to creativity. The best advertisement for Autonomatic as a group – and for their mission within the design world – is the individuality of their work.

[1] www.research.ibm.com/autonomic/overview/solution.html
[2] www.autonomatic.org.uk/index.php
[3] Ibid.
[4] Interview with the designer, UCF, 5 October 2006.
[5] Tavs Jørgensen, 'Binary Tools', research paper presented at 'In the making', Nordic Design Research Conference, Copenhagen, Denmark, May 2005. www.autonomatic.org.uk/downloads/binary_tools.pdf

dr katie burnell

Dr Katie Bunnell, Cluster Leader

Katie Bunnell's interest in new technology dates back to the early 1990s when computers were rapidly developing in power and speed. For her PhD, completed in 1998, she conducted extensive research into design-based applications for new technology.[6]

'When I did my PhD very few makers were using computers to create ceramics,' Bunnell recalls.[7] Yet surprisingly, in view of the radical improvements in technology since then, the take-up in the interim has been disproportionately low. One of the reasons for this, she believes, is that, for the artist rather than the 'techie', much of the software and digital kit remains fairly inaccessible because it relies on a mathematical rather than an intuitive approach. 'There is a real need to engage in the whole process of digital designing and making, to develop knowledge through an iterative and experiential process, to close the feedback loop between using a software tool and "seeing" the result in real material,' declares Bunnell. 'This requires a significant commitment in time with open access to technology. Many established makers and courses are unable to reconcile the loss of other skills this commitment would seem to represent.'

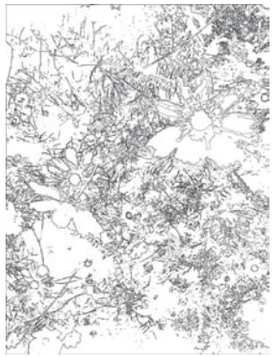
[fig 1] Cosmos mobile phone snapshot

As a designer, Bunnell's main interest lies in patterns for ceramic surfaces. In this field there is great potential for employing relatively simple 2D CAD technologies which can provide a more direct link between design and production. As well as exploring the potential of computer graphics for creating new aesthetic idioms in ceramic patterns, she also wants to take advantage of digital technology to develop more viable methods of small-scale production where the designer-maker remains in control.

These dual concerns are evident in her recent Digital Florals series, consisting of two families of patterns, Allium and Cosmos, applied to a range of bone china tableware. The patterns were created by scanning actual flowers and transferring mobile phone photographs into the computer to create the basic images. Whilst not seeking to create literal or natural depictions of plants, she finds that the immediacy of these methods gives greater vigour to her designs [fig 1]. 'I wanted to keep the flower images fresh and random,' she says. 'And in this series I wanted to do something where the software tools created the image without hand drawing playing a part in the process.'

Technical wizardry is no substitute for the designer's eye, however. The key to creating a successful pattern is often to pare down and simplify. In fact, the main problem for the designer working with digital technology is having too much choice, rather than too little. 'During the process, I have to be highly selective about which bits of information I use, because there's so much of it,' she observes. [fig 2]. Bunnell plays with the images, honing particular details, altering contrast and brightness, picking out different line qualities and experimenting with colour. 'Programmes such as Photoshop and Illustrator obviously offer a vast range of possibilities for image making, but I tend to experiment with the specific characteristics of a limited range of tools, as you might in the workshop with your trusted modelling tools'.

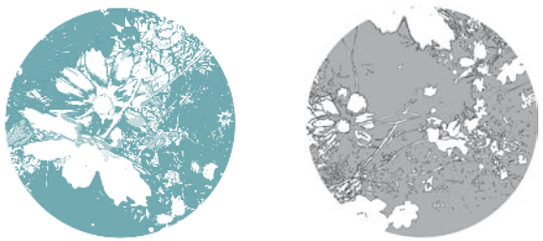
The Digital Florals range could easily be mass-produced, but Bunnell prefers to operate as an independent designer-maker and to produce her work on a smaller scale.'The traditional process of screen-printing ceramic decals is time-consuming, the materials are toxic and the nature of the print process often makes mass manufacturing an economic necessity,' she points out.[8] 'The ceramic digital printer represents a new age of surface pattern prototyping, making it possible to customise one-off pieces for individual clients or prototype a wide range of designs for product testing.'



[fig 2] Cosmos digital drawing

Using digital technology means that, in theory, each item can be created with its own unique image in its own special colourway, although in practice Bunnell finds that most consumers prefer the designer to take the lead. Because her patterns are so graphic, each piece in the Digital Florals range is strong enough to stand on its own. But when it comes to tableware, the idea of complementarity was central to her design concept. A mix-and-match service composed of pieces in different colours was what she had in mind, an idea that has struck a chord with consumers [fig 3].

In August 2006 Bunnell was invited to participate in a group show called Hidden Art Curated at Godolphin House in Cornwall. Initiated by Hidden Art Cornwall [9], the exhibition placed contemporary objects within the period rooms of a Grade 1 listed country house, partly dating back to the 15th century. Her contribution was a group of plates inspired by – and wryly commenting on – a 19th century tableware service by Mason's Ironstone China. Her 21st century re-interpretations were displayed alongside the originals in a traditional wooden dresser.



[fig 3] Cosms plate design i & ii

Bunnell was intrigued by the notion of ‘design theft’ and the pivotal role this has played – and continues to play – in the history of decorative art. Such practices have loomed particularly large in the ceramics industry, where technical secrets and decorative motifs have been freely co-opted by one country from another, or copied by rival factories in close-knit manufacturing communities, such as the Potteries in Stoke-on-Trent. Mason’s Ironstone China, dating from 1813, provides a classic case of ‘design theft’. Miles Mason in effect ‘stole’ the recipe for this ground-breaking new ceramic body from a bankrupt competitor, while the decorative motifs were derived from imported Chinese porcelain. Bunnell takes up the story: ‘I read about Mason’s history: how they developed a “fake” china body; and how they “stole” the patterns from oriental porcelain. So, in the spirit of this “theft”, I “stole” Mason’s patterns for my designs.’

[fig 4] detail of Mason’s ironstone plate

Of course, when Bunnell refers to ‘stealing’, she is speaking in an ironic Post-Modern sense. While Mason’s motivations for copying were blatantly commercial, Bunnell plays with the idea of copying for purely artistic reasons in a self-consciously knowing way. The issue of design plagiarism, however, remains extremely topical, although the geographic and economic trends that characterised Mason’s era are now being neatly reversed. In our globalised 21st century world it is Asian manufacturers who are unashamedly copying (rather than being copied by) the West. Finally, two centuries down the line, Europe is getting a taste of its own medicine – poetic justice perhaps. Significantly, the main tool for present-day plagiarism, both literary and visual, is new technology. The cutting and pasting of text from the internet is a growing problem in schools and universities. Similarly, in the design world, shapes and patterns are much more easily copied with the aid of 2D and 3D digital scanning. Bunnell’s work comments indirectly on these negative trends, but demonstrates how digital technology can be used in a positive way. Inspired by the individualised hand-painted quality of the originals, Bunnell’s initial idea was to develop methods for digitally ‘drawing’ directly onto porcelain. She started by taking a digital photograph of one of the Mason’s plates, focusing on a section of pattern featuring a vase of flowers [fig 4]. From this she extracted an outline image on the computer [fig 5], which was then transformed into a pattern composed entirely of concentric lines using a piece of software designed specifically for architectural plans. The resulting

[fig 5] Mason’s revisited i
[fig 6] Mason’s revisited ii

[fig 7] CNC plotter cutter drawing with ceramic ink
[fig 8] Mason's revisited ceramic decal design

pattern, recalling a cross section through a tree trunk, is fluid but slightly geometricised, with a quasi-Op Art quality [fig 6].

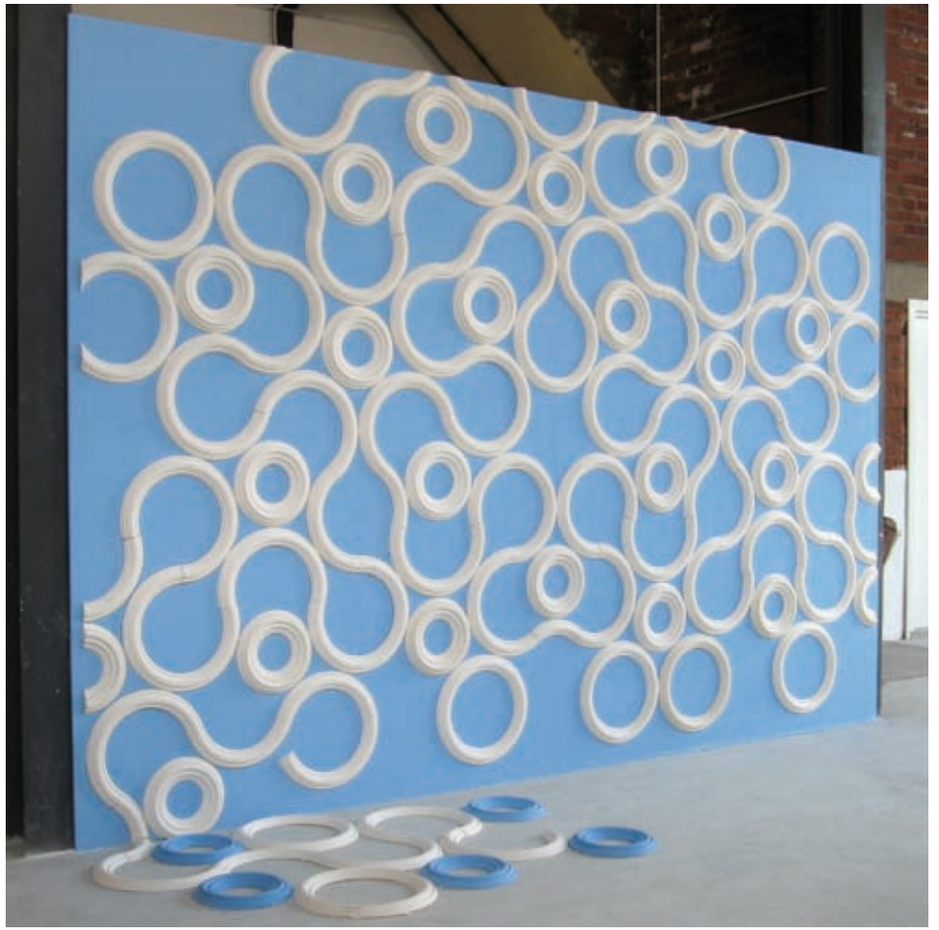
The next step was to transfer the pattern onto a sheet of ceramic paper using a digital plotter-cutter, a simple machine widely employed in the sign-writing industry for cutting lettering out of vinyl. Bunnell experimented with rigging up the machine with a technical drawing pen filled with ceramic 'ink' and with ceramic pencils. Both tools required her to 'pause' the machine while drawing to shake the pen and sharpen the pencil – just as in hand drawing. Consequently each drawing of the same image has its own imperfections and idiosyncracies [fig 7]. The ceramic paper drawing was then placed in a plate mould and clay was pressed in from behind. In this way the surface decoration was applied at the same time as the plate was moulded.

At this stage, however, Bunnell realised that, although these techniques showed great potential, they required further development to make them really successful. For the Hidden Art Curated exhibition, therefore, she returned to the tried and tested technique of digital decals on bone china blanks. By exporting the images created using the plotter software back into Illustrator, she was able to create several versions of the pattern. The colours chosen for the digital decals were deliberately subtle, so that, when displayed, Bunnell's plates appeared to be part of the Mason's service at first glance. It was only on closer inspection that visitors became aware of her subversive substitutions [fig 8].

One of the advantages of working within the framework of a university is that free-ranging research and experimentation are actively encouraged. The Design Centre at UCF, with its impressive array of CAD/CAM equipment, is ideal in this respect. However, as every scientist knows, only a small proportion of experiments are successful. The same is true for designers, especially in the digital arena where so much technology is still in its infancy. Transforming the virtual into the tangible throws up many problems. There is often a mismatch between digital visualisations and the physical reality of materials science, particularly in ceramics with its complex chemistry and physics. Although frustrating at times, this can act as a spur. It is all part and parcel of the challenge of being a digital design pioneer.

[6] Dr Katie Bunnell, Re:Presenting Making – The Integration of New Technologies into Ceramic Designer-Maker Practice, The Robert Gordon University, Aberdeen, 1998.
[7] Interview with the designer, UCF, 5 October 2006. Unless otherwise indicated, all subsequent quotes from Dr Katie Bunnell are derived from this source.
[8] www.autonomatic.org.uk/katie.php
[9] An offshoot of the London-based orgnisation, which promotes the work of designer-makers. www.hiddenartcornwall.co.uk

dr justin marshall



Dr Justin Marshall, Research Fellow

It is difficult to attach a label to Justin Marshall. His practice encompasses sculpture, computer graphics and 3D design, and spans a wide range of media, from ceramics to plasterwork to inflatables. He uses the term artist/designer to denote his profession, but also refers to himself as a researcher.

This reflects his winding academic path: a BA in Fine Art, followed by an MA in Ceramics and a PhD on the role of new technology in designer-maker practice.[10] Within the context of Autonomatic, one of his main agendas is to develop a model of economically sustainable practice for independent designer-makers by forging new relationships with industry based on the use of digital technologies.

From a creative point of view, Marshall is interested in harnessing digital technology to explore the relationship between different dimensions; in his words, 'how the 2D becomes 3D and conversely the 3D becomes 2D; how image becomes object and object becomes image.'[11] In the past he has worked extensively with ceramics, but over the last couple of years he has been preoccupied with plaster – a material widely used in both sculpture and ceramics, but mainly in a secondary capacity for making models and moulds, rather than as an end product in itself. Marshall's interest lies in architectural plasterwork, the type of low relief sculptural ornament used to decorate ceilings, cornices and friezes. Such intricate ornamentation is normally associated with historic houses, but he wants to create overtly 21st century designs. 'My idea is to try to reinvent plasterwork for a contemporary context,' he declares.[12]

In 2004 he made a series of wall-based sculptures called 'Back to where I started' using the traditional plasterwork techniques, including 'running' and 'spinning'. These processes involve drawing a metal template through setting plaster to create either curved or straight plaster units which resemble extrusions of the 2D profiles [fig 1]. Much of the plasterwork he produced in this period was based on shadows of his body [fig 2]. The following year, prompted by a competition brief set by Autonomatic, he embarked on an ambitious project called Coded Ornament. Working with Hayles & Howe, an architectural plasterwork firm in Bristol [13], he set out to apply digital design and production technologies to this most conservative of manual crafts. His aim was to find out whether CAD/CAM technologies could be used in conjunction with the traditional skills and processes to create an innovative new range of plasterwork products. Collaborating with Hayles & Howe provided the opportunity to work on a scale – and to achieve a quality of finish – that he could not achieve on his own. Coded Ornament took the form of four mini projects exploiting a variety of digital technologies, including computer numerically controlled (CNC) milling machines, computer controlled lasers and rapid prototyping (RP).[14] 'I wanted to test these technologies out to see if they might actually be useful within the context of decorative plasterwork,' recounts Marshall. 'I also wanted to try to keep the actual computer work as simple as I could. It wasn't about being really fancy and using very expensive or complicated software. I deliberately used relatively simple 2D software like Illustrator and Photoshop.'[15]

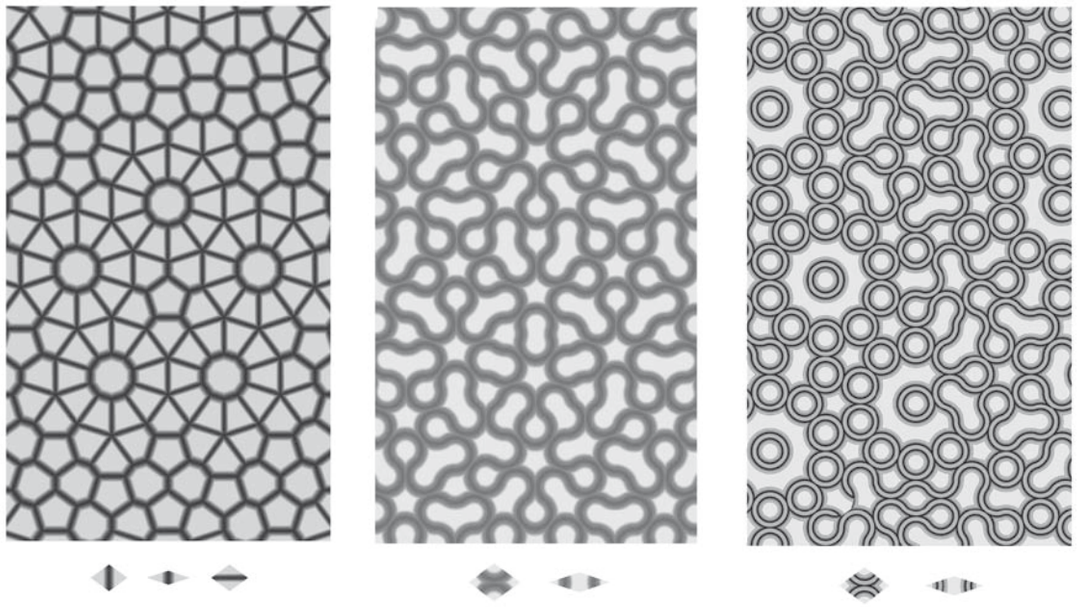
[fig 1] Running plaster by drawing a 'sledge' containing a metal 2D profile through setting plaster.

Architectural plasterwork – like ceramic tiling – naturally lends itself to a modular approach. For his Penrose Strapwork series, Marshall used Penrose Tiles – the non-repeating modular tiling systems developed by the mathematician and physicist Roger Penrose – as his starting point. Penrose Tiles are aperiodic, which means patterns of infinite variety and complexity can be created from simple repeated geometric units [figs 3-5]. Computers, of course, are ideal for these kinds of elaborate geometric pattern-making experiments. The Penrose Strapwork pieces (alluding to 17th century strapwork) consist of varied compositions of raised circles and snaking lines. The patterns appear to be free and organic, but the underlying structures are modular and geometric: the designs are created digitally by juxtaposing two different-shaped relief-decorated rhomboid tiles.

It was the flexibility of Penrose tiling that particularly appealed to Marshall: the ability to create continuous, non-repeating, apparently 'random' patterns from two basic geometric units, simply by aligning them in different ways. Mass customisation was another attraction: unique patterns created from standardised components to suit particular interiors. To demonstrate its artistic potential, Marshall has created a number of large-scale wall-mounted installations with arresting, meandering patterns 'leaking' onto the floor. Similar ideas could be applied to dramatic effect in interiors, he believes, with patterns slithering off ceilings and oozing around windows and doors.

These experiments led to a second series called Stepped Relief, a modular plasterwork system created from rectangular and curved strips of Penrose Strapwork, greatly reduced in size. The units are designed so that the patterns always join up when placed end to end, creating long undulating compositions, a bit like a maze. These designs were created using 2D software (Illustrator); no 3D modelling was involved. The elements for the master models were laser cut from sheets of hardboard, glued together in stepped layers [fig 6]. 'This is quite a flexible and easy form of production which combines digital cutting with traditional model making,' the designer notes.

[fig 2] 'Back to where I started 3', 2003, 1m diameter, run plaster.



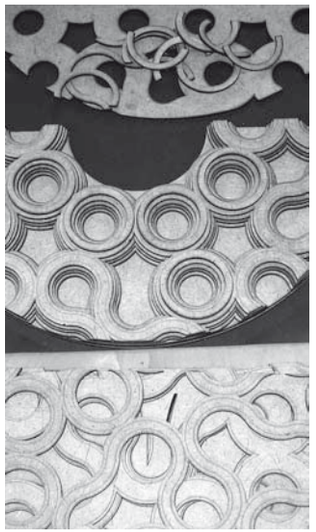
[figs 3–5] A variety of designs based on arranging two Penrose ‘rhombs’ in different configurations. The basic units for each design are shown at the bottom of each design.

Whereas some designers revel in complexity, Marshall takes great delight in devising the simplest solutions. His third plasterwork series, From Image to Low Relief. although apparently complicated, is remarkably straightforward in practice. Rather than being newly drawn, these designs exploit ‘found’ digital motifs. Larger units of composite pattern are built up from small standardised components in cleverly synchronised arrangements. On closer examination these small components are revealed as ‘ready-made’ digital characters, such as asterisks, brackets, hyphens, apostrophes and full stops, sampled from the ubiquitous family of typable symbols in word-processing and graphics programmes. The knock-on effect of this design strategy is that simple click-of-the-mouse actions, such as altering a font, trigger dramatic changes in the visual character of the patterns.

The next stage is to apply a filter to blur the edges of the motifs. From this grey scale picture – and it is just a picture, Marshall emphasises – a low relief form (2.5D rather than 3D) can be created by assigning heights to different shades of grey. A milling machine was then used to produce a model from which a silicon mould was taken. Although Marshall has some reservations about this idea as a final design solution, as a process he believes it has potential for further development. Once again, the advantage is that it requires neither drawing nor 3D modelling; designs are created simply by arranging type in a certain way.

The idea of exploiting typography as the basis for a new visual-digital language was also explored in his fourth series, Morse Units, inspired by morse code. Two basic plaster units were created, one circular (representing a dot), the other linear (representing a dash). The letters h&h (for Hayles & Howe) and jgm (for Justin Guy Marshall) were incorporated into the plaster profiles, so the units were secretly encoded with the initials of their designer and maker as well [figs 7-8].

The concept was to produce a batch of dots and dashes and to use them like ‘giant fridge magnets’ to write messages in morse code on the wall. As Marshall points out, ‘In the past decoration carried symbolic meanings that were widely understood, but these meanings have now been lost. Morse code is fast becoming a lost form of communication. With its language of dots and dashes, it is based on a binary code (zeros and ones – the basis of all computer programming), so it seemed appropriate to co-opt it for digitally-designed decorative motifs. My idea was to revive the notion of decoration as a vehicle

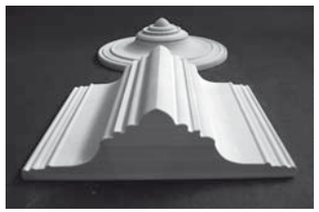


[fig 6] 2D laser cut hardboard elements to be used in the construction of master models for the ‘Stepped relief’ work.

for messages. I wanted to suggest the idea of decoration as a language, and to explore the notion of language as a decorative scheme.'[16]

Coded Ornament was launched at an exhibition at the Paintworks in Bristol in June 2006. Large-scale installations of the Penrose Strapwork and Stepped Relief designs, in imaginative and irregular compositions, have since been featured in two other shows.[17] Marshall describes the outcomes of Coded Ornament as 'propositional works'. For him, the project provided a platform for exploring new ways of thinking about craft by applying digital technology. Although he is not proposing CAD/CAM as a wholesale replacement for traditional methods of designing, modelling and manufacturing plasterwork, he has shown that it can serve as a useful tool for extending possibilities. In the future he is keen to build on his relationship with Hayles & Howe by undertaking major architectural commissions. 'I'm very interested in making connections between craft practices and architecture,' he says. 'We've done our homework. We're at the stage now where we can do live projects.'

[fig 7] The profile used to produce the 'Morse code' work which was derived from project participant's initials.
[fig 8] Elements of the CNC milled master models for the 'morse code' work.



[10] Dr. Justin Marshall, The Role and Significance of CAD/CAM Technologies in Craft and Designer-Maker Practice: with a Focus on Architectural Ceramics, University of Wales Institute in Cardiff, 2000.
[11] www.autonomatic.org.uk/autoteam.html
[12] Visit www.haylesandhowe.com for further details
[13] Interview with the designer, UCF, 4 October 2006.
[14] www.autonomatic.org.uk/autokit.php
[15] Dr Justin Marshall, 'Coded Ornament', lecture presentation at the Paintworks, Bristol, 17 June 2006. Unless otherwise indicated, all subsequent quotes from Dr Justin Marshall are derived from this source.
[16] Interview with the designer, UCF, 4 October 2006.
[17] "Hidden Art Curated', Godolphin House, Cornwall, 2006, Perimeters,Boundaries and Borders: an f.city exhibition by Fast-UK and Folly, Lancaster, September 2006

drummond masterton

Drummond Masterton, Research Assistant

To call Drummond Masterton a metalwork artist is misleading as this implies he works with his hands. The objects he creates are finely crafted and intricately decorated, yet they are designed on the computer rather than on the drawing board, and made 'remotely' by a computer-numerically controlled (CNC) milling machine.[18]

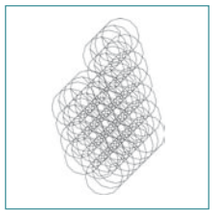
Yet, to suggest that Masterton is a metalwork designer (in the conventional sense) is equally off-the-mark. His pieces are sculpted out of solid metal, usually aluminium, but although they masquerade as functional domestic objects, such as tumblers and bowls, his primary interest is low-relief sculptural surface decoration. 'I'm interested in how pattern is applied to form,' he says. 'I want to create "mundane" everyday objects – but with a play of pattern on the surface.'[19]

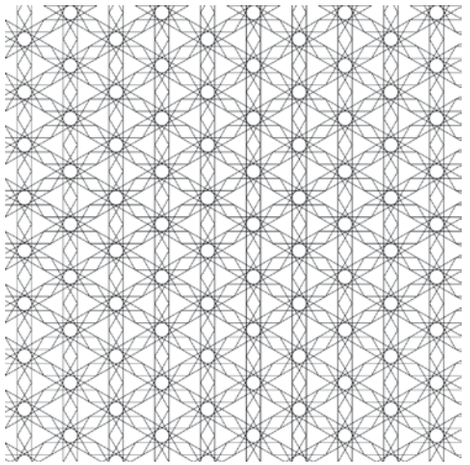
Although Masterton's pieces are machine-made using high specification engineering equipment, they are surprisingly modest in scale and – more surprising still – they are usually produced as one-offs. 'The kind of research I'm doing is very time-consuming,' he explains. 'It involves understanding how the 3D software works and how the milling equipment functions – its characteristics and its limitations.' Indeed, judged from a purely commercial point of view, the length of time he invests in designing each object and the number of hours required to manufacture each piece on the milling machine (usually 20-40), is out of all proportion to their actual scale.

The key point to understand though, is that Masterton is consciously (even subversively) using the machinery out of context, driven by his fascination with the untapped visual potential of digital technology and the craftsman's desire to create ever more complex work: 'I am interested by the idea of complexity and how things that exhibit complex tendencies seem to be able to be created from the layering of simple actions and components,' he elaborates. 'These layers can be seen as variables that have many different possible inputs and therefore can generate an almost infinite number of outputs.'[20]

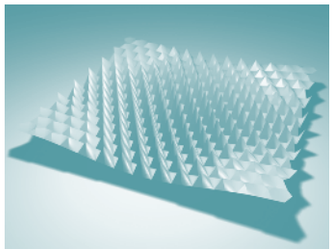
One of the criticisms of objects produced using digital technologies is that they can seem very sterile, Masterton admits. Addressing this problem requires him to delve into the complex world of mathematics, as it is mathematical systems that underlie all CAD software. One area of research on which he has been focusing is star tessellation sets. 3D design software naturally lends itself to creating tessellated patterns because it is based on the principle of building shapes from simple repeated geometric units, such as triangles, squares or hexagons. 2D triangle patterns (the lowest form of tessellation) are readily converted into 3D forms by saving them as Stereolithography (STL) files. This explains why so many objects created by rapid prototyping or CNC milling are characterised by triangulated effects. Unlike other designers, however, Masterton is not content to allow the software to dictate the visual character of his designs. 'I like the idea of starting with simple forms and developing them into something more complex, but I'm trying to get away from triangulation by masking the triangles out, so the patterns end up like contours.' [figs.1-3]

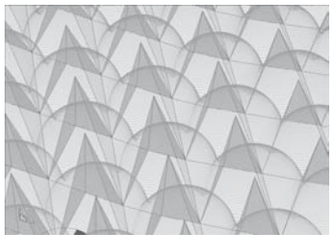
Masterton's aim is to remove the uniform machine aesthetic by achieving greater control over the technology. What he aspires to are 'results that are closer to hand work such as engraving, although paradoxically still unachievable by hand.'[21] One way of attaining greater flexibility and variety is by exploiting a combination of 2D and 3D design software, transferring data between different programmes at key stages during the design process. In addition to 3D Studio Max and the CAM milling programme Mayka,[22] he also uses several 2D programmes, notably Illustrator for designing patterns and Corel Draw for editing drawings. 'I dissect software, looking for something that will allow me to develop a shape, form or pattern that is unique,' he says.[23]

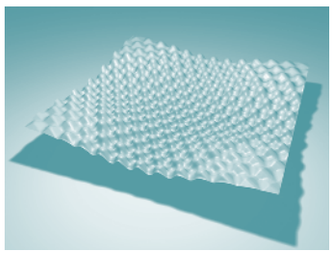




[fig 1] Individual geometric units of Star Tessellation 3.
[fig 2] Several units combined to show
the formation of the tessellation.
[fig 3] The completed tessellation.







Masterton has developed a technique that enables him to control the movement of the cutting tool in the milling machine using patterns originally designed in 2D. 'This has opened up a whole new area of exploration and has allowed me to cut both 3D form and pattern simultaneously,' he enthuses.[24] First he creates a 2D tessellated grid from a combination of specific topological elements such as hexagons, squares and triangles using Illustrator. This file is then transferred to 3D Studio Max and the flat pattern is converted into 3D form, either by distorting the vertices of the grid, as in his gently undulating Hexabubble Bowl; or by laboriously raising and lowering the surface point by point, as in his glittering Tessagon Bowl. The Hexabubble was further modified using Mayka to soften the angularity of the geometricised surface. This data is then fed into a CNC milling machine which cuts the design from aluminium [figs 4-6].

Because much of Masterton's work is experimental, he often tries out his ideas initially as small trial samples. Much of his time is spent testing and logging the results of different variables, such as the contrasting textures arising from subtle changes in cutting parameters within the CAM software. Numerous design modifications are also available through Mayka. For example, the width of the cut can be varied, and hand-drawn lines created in Illustrator can be translated into milled lines. Successful outcomes from these trials are later applied to finished pieces, such as a Pen Case decorated with contrasting hand-drawn and machine-drawn lines [figs 7-8].

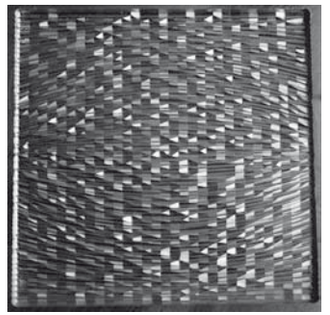
Another way of increasing variety is to intervene directly in the modus operandi of the milling software by resetting the programme so that the machine performs non-standard cutting actions. 'I'm trying to break out of the predictability of the normal CAM aesthetic,' explains the designer. 'By playing around with the codes I can exert direct creative influence. I'm trying to find the unknown variable – the hidden or secret aspect of digital design where you can't predict the results.'

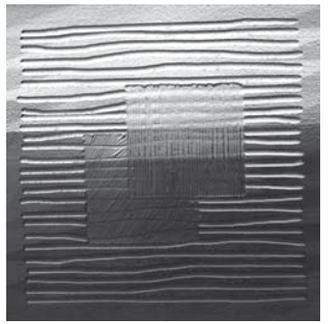
[fig 4] Grid showing vertices that have been individually distorted.
[fig 5] The 3D surface is modified in Mayka by simulating a cutting path.
[fig 6] The sharp and softened surfaces are combined to create a new form.

By 'tampering' with standard software, Masterton is seeking to broaden the applications of digital technology, sometimes by deliberately subverting it from its designated course. 'I'm using the computer more like a tool, such as a hammer. There's an element of hand control,' he declares. At times he consciously 'misuses' the CNC milling machine, by directing it to perform actions that would normally be classed as errors or faults by an engineer. 'I feel it is more important to have a misunderstanding of these tools,' he stresses, 'as this presents ways to utilise them which were not thought [of] by the developers, but are unique to the individual.'[25]

Masterton's work raises the question, is digital design craft? This is clearly pertinent to the designer himself, who cites Japanese netsuke – intricately carved miniature sculptures made from ivory or wood – as one of his inspirations. His self-proclaimed alliance with fine craftsmanship and uniqueness, rather than industrial design for mass production, is central to his work. 'I'm building up a skill base and a knowledge base in CAD/CAM technology,' he says. 'I'm physically engaged with the process of digital design in a direct way – just like a craftsman. I don't want to rely on a technician to translate my ideas. I want to be both a designer and an engineer.'

Masterton's engagement with the technical aspects of digital technology may still be something of a rarity within the crafts world, but the significance of his pioneering endeavours were recognised recently by leading craft historian Tanya Harrod. When invited to select work for a European contemporary craft exhibition called Languages in 2005, Harrod chose a milled aluminium cup and saucer by Masterton entitled Terrain.[26] The well of the cup and the saucer are both modelled with a miniature relief sculpture of Ben Nevis. When placed together, the two models interlock. Works such as these, which play around with scale, have obvious parallels with netsuke. The phrase 'storm in a tea cup' comes to mind in relation to this piece: through digital technology Masterton has performed the seemingly impossible feat of shrinking a vast geological feature inside a humble drinking vessel.



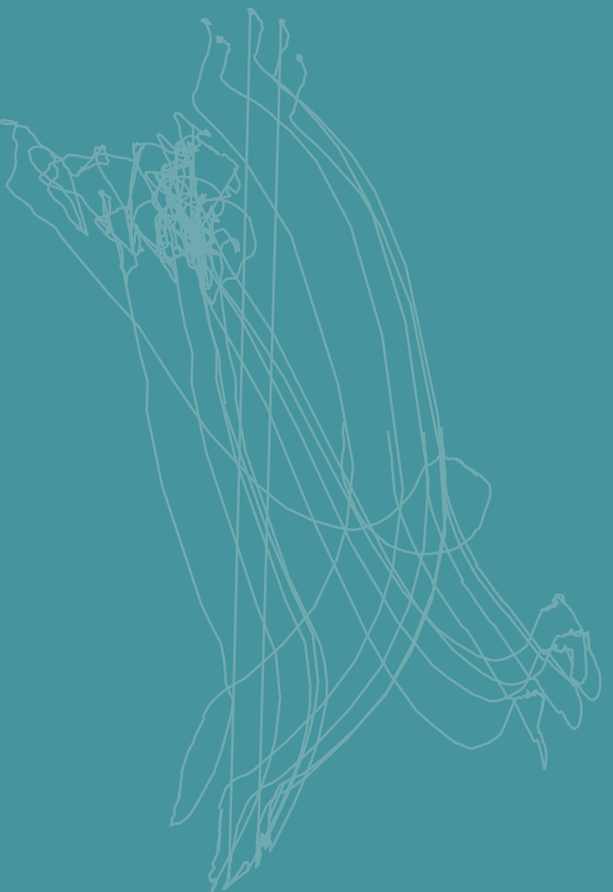


[fig 7] A 3D surface was created and then distorted using a displace modifier in 3D Studio Max.
[fig 8] Engraved lines were created using a Maxscript which allows the user to draw a line directly on a 3D surface as if you were using a pencil.

Masterton's work was also shown recently in the Devon Guild of Craftsmen's Interface exhibition focusing on digital craft.[27] In addition to Terrain, the exhibition included his series of milled silver, brass and aluminium Whisky Cups. Such meticulously detailed, finely wrought creations are made possible through working in a 'research and development' context. That is the beauty of the set-up at the 3D Digital Design Research Cluster at UCF: it allows technically-orientated designer-makers to experiment freely with state-of-the-art digital resources (both software and hardware) – the type of equipment that would normally only be available to engineers – for purely creative ends.

[18] Bridgeport 3/4/5 Axis Milling Machine VMC1000. www.autonomatic.org.uk/autokit.php
[19] Interview with the designer, UCF, 5 October 2006. Unless otherwise indicated, all subsequent quotations from Drummond Masterton are derived from this source.
[20] Drummond Masterton, 'The hunt for complexity,' research paper, UCF, 2004, p.6. www.autonomatic.org.uk/downloads/The%20hunt%20for%20complexity.pdf
[21] www.autonomatic.org.uk/drummond1.php
[22] Mayka is CNC software designed for the creation of toolpaths from 3D surfaces and 2D vectors in 3, 4 and 5 axis. For more information, see http://www.picasoft.com/english/mayka.php
[23] Drummond Masterton, 'The hunt for complexity,' 2004, op. cit., p.6
[24] www.autonomatic.org.uk/drummond1.php
[25] Drummond Masterton, 'The hunt for complexity,' 2004, op. cit., p.11
[26] Languages, touring exhibition organized by Think Tank, shown at Galerie 422, Gmunden, Austria, September 2005; Museum für Angewandte Kunst, Frankfurt, Germany, October 2005–January 2006; Gallery West, University of Westminster, Harrow, London, January–March 2006; Museum of Art and Design, Copenhagen, Denmark, March–May 2006.
[27] Interface, Devon Guild of Craftsmen, Bovey Tracey, Devon, 23 September–5 November 2006. The exhibition also included work by Justin Marshall and Tavs Jørgensen.

taus jørgensen



Tavs Jorgensen, Research Fellow

Ceramics designer Tavs Jørgensen might seem a somewhat unlikely new technology activist, although in fact he has been actively engaged in the digital field for several years. Originally apprenticed as a craft potter in his native Denmark, he moved to Britain in 1991 and initially worked as a production thrower at Dartington Pottery in Devon.

After completing a BA in Ceramics in 1995, he established his own design consultancy. Jørgensen joined Autonomatic as Associate Researcher in May 2005 and was appointed Research Fellow in April 2006. He also teaches part-time in the Ceramics and Glass Department at the Royal College of Art, as well as continuing his independent design consultancy work.

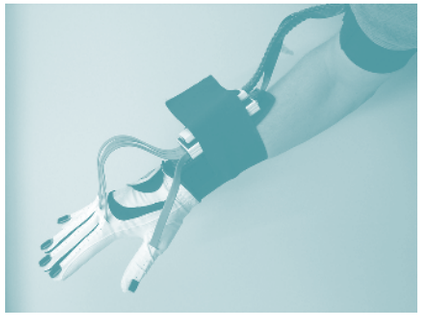
He first became involved with digital design technology after being invited to participate in a rapid prototyping (RP) project by Martin Woolner from the University of Plymouth in 2001. The outcome was a series of ribbed and indented slip-cast bone china bowls, called Contour Cups, evoking the contour lines on maps. This design was prompted by the characteristic layered appearance of items created by Laminated Object Manufacture, a type of RP whereby 3D forms are built up from thousands of layers of laser-cut paper glued together. In the final models, MDF was used instead of paper to exaggerate the layered effect. 'Normally this visual evidence of the process is undesirable,' observes Jørgensen. 'Enlarging and emphasising [the layers] had the potential of creating a strong visual feature that reflected the nature of the construction process.'[28]. A second project, undertaken with the University of Plymouth, Ceramic Origami (2003–2004), resulted in a range of porcelain vessels called Helix, launched in September 2004. This time Jørgensen used CAD software to deconstruct a jagged tapering helix-like 3D shape into a series of polygonal planes, creating a flat 2D template from the 'unfolded' 3D form. A plotter-cutter was then used to cut the template from a sheet of polypropylene and to score the lines for the folds. Once assembled, the model was used to cast a one-piece plaster mould.

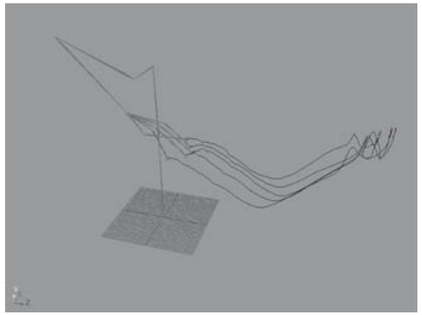
Although committed to digital technology, however, Jørgensen (like other members of Autonomatic) is frustrated with the limitations of CAD from a creative point of view. In many respects computers are 'unintuitive' and essentially 'alien' to hands-on designer-makers, he feels. Like his colleagues, he dislikes the way commercial software directs – and often predetermines – the designer's aesthetics. The uninspiring physical presence of the computer itself is also a drawback: its bland anonymity and its lack of sensory responsiveness. 'Creating with a CAD package is essentially a very static and calculating exercise,' he remarks, 'far removed from the craft maker's intuitive making process.' His ambition is to introduce an element of physicality into virtual design: 'I want to use digital technology but to incorporate the hand,' he declares.

[fig 1] G2 Microscribe digitizing arm

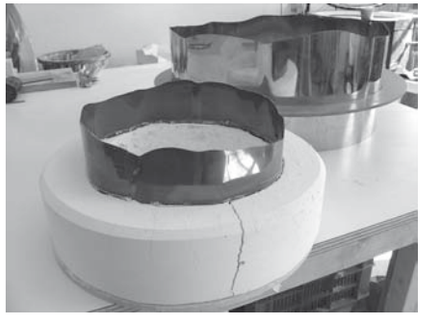
His search for unconventional solutions to this problem led him to a piece of equipment called the G2 Microscribe digitizing arm: a 'point and click' device used for scanning 3D objects by taking lots of measurements [fig 1]. By co-opting Microscribe as a free-hand tool, Jørgensen discovered that it could be used to create 'digital drawings', recording movements rather than form. These drawings were much more fluid, calligraphic and spontaneous than those created using CAD software. Thickening the lines and giving them volume meant that they could be physically represented as a solid. The drawings could then be produced as 3D objects by rapid prototyping. Jørgensen employed this technique to create a set of trophies for the UK Science Park Association in 2004.

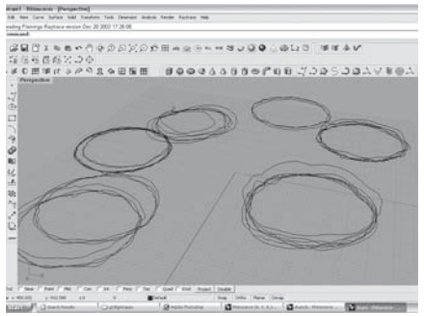
Since 2005 Jørgensen has been experimenting with another means of incorporating the physical into the virtual via the Shapehand ™ motion capture glove [fig 2]. This device – originally developed for use in animation and special effects – is literally a glove wired up to a computer, which translates hand movements into digital drawings [fig 3]. Much more flexible than the Microscribe, it captures the dynamics of individual digits as well as the motion of the whole hand and arm. Jørgensen believes that Shapehand has potential for crossover applications in design, particularly if it is used as a creative tool, rather than merely as a mechanical tracking device. 'The opportunity of using such equipment offers the exciting prospect of creating with free and unhindered gestural movement,' he enthuses. By injecting human qualities such as playfulness, spontaneity and informality into digital design, Shapehand provides a liberating alternative to the stultifying perfection of CAD. Drawing parallels

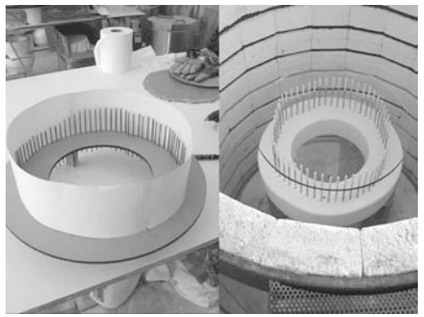


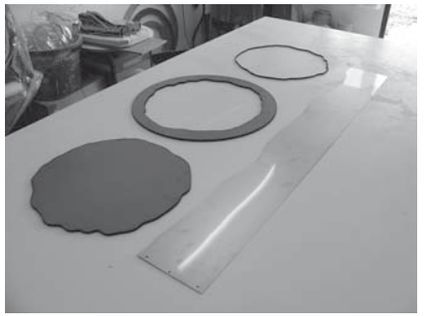


[fig 2] Shapehandplus™ Motion Capture Glove
[fig 3] Hand motion shape recording









From top
[fig 4] Milling of hand motion shape
[fig 5] 3D hand drawn bowl rim defining loops
[fig 6] Laser cut stainless steel
'line' for glass slumping

From top
[fig 7] Stainless steel mould for glass slumping
[fig 8] 'Point line' mould for glass slumping

with the throwing lines on wheel-thrown pots, he says. 'What I'm trying to do is to capture evidence of the human hand in motion, right down to the trembling of the fingers.' [29]

So far the creations arising out of the Shapehand project have taken a number of different forms. The initial concept was to develop new ways of creating ceramic vessels reflecting or embodying hand gestures. CNC milling was used to cut sculptural forms in foam from which plaster moulds were produced [fig 4]. These moulds were then used to create slip-cast ceramics vessels. Shapehand has also been employed to create some patterns on a range of tea towels. The twist is that the patterns capture motion images of the hand whilst drying up.

Jørgensen is now developing new applications for the concept in other materials. Recently he used Shapehand to design a collection of stools with milled resin seats. Laid out in a row, the stools resemble an aerial view of a range of hills. However, the contours are the physical embodiment, not of a landscape, but of a hand movement travelling through time.

For his latest digital design experiments Jørgensen has returned to the Microscribe, this time harnessed to record the act of drawing a circle freehand in the air [fig 5]. The drawing is then used (kinks and all) to delineate the rim of a glass bowl. The first stage in the process involves extruding and unfolding the digital line. This serves as a guide for laser-cutting a ring of stainless steel [fig 6]. The metal collar is placed in a kiln with a disc of glass on top. When the glass softens in the heat, it slumps over the irregular contours of the stainless steel ring [fig 7]. 'This is a good example of collaboration between digitally recorded movement and the innate physical properties of hot glass,' Jørgensen notes.

Authenticity – being true to the process and not ironing out imperfections – is a distinctive feature of Jørgensen's approach to digital design. This philosophy is reflected in his second glass-making project. Because the Microscribe operates by taking a series of measurements at intervals, the digital drawings it creates are not, in fact, continuous lines, but a series of dots. 'The linear path is not the actual motion, but a series of points joined by lines,' he explains. Exploiting this idea, a range of bowls was formed by slumping a sheet of glass over a ring of upright metal rods set at varying heights, instead of a continuous metal band [fig 8]. The rods represent the co-ordinates from which the digital drawing is composed, rising and falling in the wavering motion of the hand-drawn circular line. This time the rim is not only wavy, but indented with a line of dots as well.

Jørgensen's research is highly exploratory and is very much about crossing boundaries. Dissatisfied with the inadequacies of existing CAD software, he pursues new avenues by experimenting with technology from non-design fields. Although he remains committed to ceramics, he is enthusiastic about exploring potential applications in other media. 'It's more about an approach than about working with a particular material,' he concludes.

By interacting with computers in a more direct and physical way through devices such as Shapehand and Microscribe, Jørgensen uses digital technology as a conduit for the human hand. For him, as a designer and craftsman, this is the 'new frontier'. However, he stresses that the main driving force behind his work is to develop real-life applications for the new digital tools and making processes. 'Craft has contributed richly to the culture of our society, and it would be a great shame to lose the concept of the craft maker,' he says. 'However, the artisan has throughout history used the tools, processes and aesthetics of the present time. I believe it is crucial, if the craft maker is to remain a current and relevant part of contemporary culture, to embrace and utilise these new tools.'

[28] Tavs Jørgensen, 'Binary Tools', 2005, op. cit.
Unless otherwise indicated, all subsequent quotations from Tavs Jørgensen are derived from this source.
[29] Interview with the designer, UCF, 5 October 2006.

Endnote

In spite of the rapid spread of digital technology, which is increasingly all-pervasive in daily life, manual processes are still the norm in most fields of contemporary craft. This discrepancy only serves to highlight the significance of the 3D Digital Design Research Cluster at UCF.

Autonomatic's aim is to encourage more designer-makers to experiment with digital technologies – locally, nationally and internationally. In addition to the group's website, they are constantly reaching out to students and practitioners by participating in exhibitions, running seminars and workshops, and giving presentations about their work.

Autonomatic's mission is twofold: to explore the potential of digital technologies in designer-maker practice; and to propagate these ideas within the wider craft world. However, although actively committed to harnessing cutting edge computer-aided design and manufacturing processes – technologies that were originally, in the main, developed for industrial applications – Autonomatic themselves are refreshingly 'non-techie'. As their diverse projects demonstrate, digital technologies hold enormous potential for releasing human creativity in a multitude of different ways.

Dr Katie Bunnell believes that, with the advent of digital technology, this is a very exciting time for designer-makers. 'There's a realisation that, when traditional skills combine with new methods and equipment, the possibilities are endless,' she says. Autonomatic have a key role to play, both as role-models and opinion-formers, not only within UCF, but the Higher Education sector and the design world as a whole. 'It's not about replacing craft skills with computing, it's about bringing all the skills and traditions that we have in making, combining them with new technologies, and seeing how they might interweave and enhance each other,' she concludes.[30]

Bunnell and her colleagues provide an inspiring example of how digital technology and traditional craft skills can be fused in an entirely positive and complementary way. Their pioneering research, which is very much on-going, is leading them into dynamic and ground-breaking new creative areas. As well as enabling them to push forward the boundaries within their own particular fields of expertise, digital technology has given them the confidence to branch out and engage with hitherto unfamiliar materials and techniques.

Autonomatic want to harness and exploit digital technology, rather than be exploited by it. Often they do this by diverting – or even subverting – existing CAD software and CAM hardware from its intended path. As a group they are endeavouring to personalise the impersonal and, at times, inflexible processes that underlie computer technology. Their aim is to make digital design more responsive to human instincts and needs by giving it human hands and a human (inter)face.

Returning to the earlier medical analogy, Autonomatic are not interested in cosmetic surgery, they want to reform the entire digital design metabolism, root and branch – to implant an Autonomatic Nervous System, you might say.

Lesley Jackson, Writer, Curator and Design Historian

[30] Dr Katie Bunnell, quoted in 'Technology changes the face of design', Bigspace 2007, University College Falmouth, p.38

end

Biographies

Dr Katie Bunnell is a ceramic designer-maker, researcher and leader of the 3D Digital Production research cluster at University College Falmouth. Bunnell completed a BA in 3D Design (Ceramics) at the University of the West of England, Bristol in 1989, an MA in Ceramics and Glass at the Royal College of Art in 1993 and completed a PhD, Re:Presenting Making, The Integration of New Technologies into Ceramic Designer-Maker Practice, in 1998. In the interest of communicating practice-based research to other designers, Bunnell created her PhD thesis as a visually oriented digital document published on CD ROM by The Robert Gordon University, Aberdeen.

Bunnell's practice has involved her in running her own ceramic tableware business as a sole trader, and in design consultancy work for Liberty, Fitch RS, Royal Doulton and Poole Pottery. She has worked as a digital designer-maker, researcher and senior lecturer in Higher Education since 1995.

Dr Justin Marshall is an artist/designer and researcher. He completed a BA in Fine Art at Lanchester Polytechnic in 1988, a MA in Ceramics at Cardiff Institute of Higher Education in 1995 and a PhD, entitled 'An investigation into the role and significance of CAD/CAM technologies in craft and designer/maker practice', in 2000 at University Wales Institute Cardiff.

Since completing his PhD, Marshall has continued to research innovative applications of CAD/CAM technologies in the design and production of ceramics and plasterwork, exhibiting research outcomes in national and international contexts. He has undertaken a number of international artist residencies and two AHRC funded research projects working with Dartington Pottery, Bath Spa University and Falmouth College of Arts. He regularly delivers lectures on his research and has taught 3D Design at University College Falmouth and University of the West of England, and at a number of other colleges. He is currently a full-time Research Fellow in the 3D Digital Production research cluster at UCF.

Drummond H Masterton trained as a 3D designer at Grays School of Art, Aberdeen and at postgraduate level at the Royal College of Art in London, from where he graduated from the Goldsmithing, Silversmithing, Metalwork and Jewellery course in 2000. He has participated in a number of exhibitions including 'Intersculpt 2003', Museum of Science and Industry, Manchester, 'Languages', a European touring exhibition, 2006 and 'Interface', Devon Guild of Craftsmen, Devon, 2006. He has work in the Contemporary Art Society collection, (London) which promotes and lends the work of major British artists to public museums in the UK. He is currently a Lecturer in 3D Design, and a Research Assistant in the 3D Digital Production research cluster at University College Falmouth.

Tavs Jorgensen arrived in Britain in 1991 after completing a four-year pottery apprenticeship in his native Denmark. He completed a BA in Ceramics at Cardiff Institute of Higher Education in 1995 and since then has run his own design consultancy, working closely with Dartington Pottery as their main shape designer. He has been involved in numerous and wide ranging projects, which have focused increasingly on research into the creative use of digital technologies in his ceramic practice.

Jorgensen is currently part-time research fellow in the 3D Digital Production research cluster at University College Falmouth and part-time lecturer on MA Ceramics and Glass at the Royal College of Art, London. He continues to work as a freelance designer and frequently guest lectures and delivers national and international conference presentations.

Lesley Jackson is an independent writer, curator and design historian. Her specialist areas are 20th century and contemporary craft and design, both British and international. Her interests include furniture, lighting, glass, ceramics, metalwork, plastics, textiles and wallpaper.

Her books include: The New Look – Design in the Fifties [Thames & Hudson, 1991];'Contemporary' Architecture and Interiors of the 1950s [Phaidon, 1994]; Whitefriars Glass – The Art of James Powell & Sons [Richard Dennis, 1996]; The Sixties – Decade of Design Revolution [Phaidon, 1998]; 20th Century Factory Glass [Mitchell Beazley, 2000]; Robin and Lucienne Day – Pioneers of Contemporary Design [Mitchell Beazley, 2001]; 20th Century Pattern Design – Textile & Wallpaper Pioneers [Mitchell Beazley, 2002]; Kate Malone – A Book of Pots [A&C Black, 2003]. She also writes for various specialist magazines, including Crafts, Icon, Selvedge, V&A Magazine, Blueprint, Modern Textiles & Carpets and Modernism.

Lesley Jackson regularly curates exhibitions for major organisations, such as the Barbican Art Gallery, the British Council and the Crafts Council. Recent exhibitions include: Robin and Lucienne Day – Pioneers of Contemporary Design, Barbican Art Gallery, London, 2001; Home Sweet Home – Contemporary British Design for the Home, British Council, international tour, 2001-2003; Beauty and the Beast – New Swedish Design, Crafts Council, London, 2004-2005; Import Export – Global Influences in Contemporary Design, British Council, international tour, 2004-2006.

She is regularly invited to judge competitions and select exhibitions, most recently the Tallinn Applied Art Triennial (Estonia), Made in the Middle (Craftspace) and COLLECT (Crafts Council). Since 2002 she has been a judge of the annual international Bombay Sapphire Prize for creativity in contemporary glass.

Lesley Jackson was recently awarded a Curatorial Research Grant by the Paul Mellon Centre for Studies in British Art to research Alastair Morton and Edinburgh Weavers. The exhibition which will take place at the Crafts Study Centre, University College for the Creative Arts, Farnham in 2009.

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