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ESTABLISHING NEW PATTERNS FOR TEXTILE DESIGN: EXPLORING OPPORTUNITIES OFFERED BY DIGITAL TECHNOLOGIES FOR THE DEVELOPMENT, FABRICATION AND PRESENTATION OF REPEAT PATTERN

REPEAT PATTERN | PRINTED TEXTILE DESIGN | DIGITAL MEDIA
DIGITAL FABRICATION | INTERACTION

ABSTRACT

THIS PAPER PRESENTS AND CONTEXTUALISES A BODY OF PRACTICE-LED RESEARCH BY THE AUTHOR THAT EXPLORES OPPORTUNITIES OFFERED BY DIGITAL TECHNOLOGIES FOR THE DEVELOPMENT, FABRICATION AND PRESENTATION OF REPEAT PATTERN.

The design works described apply knowledge of repeat pattern design for printed textiles to inform and guide the use of digital softwares, media and production processes beyond those conventionally used in textile design and printing; including virtual modelling, animation, projection and laser cutting of hard materials.

Digital technologies provide an alternative platform for the creation and dissemination of repeat pattern design, encouraging exploration of movement, scale, space and interactivity. The research described encourages the exploration of physical and virtual materials and space through a variety of digital technologies for the development and fabrication of repeat pattern beyond the traditional boundaries of printed textile design.

INTRODUCTION

This paper contextualises and explicates a body of practice-led research by the author exploring opportunities offered by digital technologies for the development, fabrication and presentation of repeat pattern. Bowles and Isaac (2009: 18) state that with digital textile print production '…the designer's decision to use repeat pattern is an aesthetic choice rather than a technical necessity.' In the series of works detailed here, the author applied knowledge of repeat pattern design for printed textiles to inform and guide the use of digital software, media and production processes beyond those conventionally used in screen and digital textile design and printing. The use of virtual modelling, animation, projection and the laser-cutting of hard materials enabled explorations between the virtual and the physical, investigating ways to generate and present pattern in two-, three- and four-dimensions.

Digital media and technologies provide an alternative platform for the creation and dissemination of pattern design, encouraging exploration of movement, scale, space and interactivity. Braddock-Clarke and Harris (2012: 8) assert that through digital media, '[n]otions of space and time are constantly shifting and evolving, owing to successive emerging computing concepts that will continue to influence advances in technology for the unforeseeable future.' In this huge and morphing arena where the possibilities of what can be achieved aesthetically and technically are seemingly boundless, the author used traditional textile design principles for the construction of repeat pattern as a framework to guide and inform the investigation of new tools and media.

Repeat pattern structures developed in response to the constraints imposed by evolving historical textile print production technologies have contributed to a rich heritage of pattern design methods and styles for contemporary designers. Bunce (1994) describes this in her early paper, 'The effects of technological developments on pattern structures used in printed textiles',

> *The effects associated with redundant [printed textile production] techniques have usually been adapted for established and later processes and, therefore, a large part of the designer's visual vocabulary derives from past attempts to exploit or work within the limitations imposed by earlier techniques. (Bunce 1994: 150)*

Where parameters on scale, colour and repeat have been lifted by successive printing technologies, designers still choose to reference and build upon ways of working informed by previous technological constraints. *Willow Boughs* 1887 by Christopher Pearson (2005) is a projected, animated wallpaper based on William Morris' 1887 block printed wallpaper and fabric pattern. Pearson (2005) replicated, animated and introduced a new narrative to the historic pattern design bringing it to the attention of a new audience in an examination of, and a tribute to, Morris' skills as a designer. Morris himself studied historic textiles to inform pattern structure in his own designs (Parry 2013), and the depth and movement that his pattern compositions capture on a flat plane informed the development of Biohazard (McLeod 2011), the first work by the author discussed later in this paper.

As well as providing new possibilities for the presentation of repeat pattern, digital technology and software also present new methods of image or motif generation for pattern design, and for the generation of pattern itself. In 1997, Eros Tang used a 3D modelling software to model floral imagery for digital print (Braddock-Clarke & Harris 2012). Daniel Brown's '*On Growth and Form*' series makes use of mathematical equations to generate unique digital floral imagery that can be output as time lapse animation for projection or flatscreen, or as print on a range of substrates at large- and small-scale (Brown 2014). Pattern types evolve in response to technology, but they can also be used to guide its use. Russell (2011: 173) asserts that, 'Although the technology may be changing, the qualities that make pattern good remain largely unchanged.' In his design research project, *Cloth of Gold*, Russell applies these qualities to the digital generation and printing of non-repeating pattern (Russell 2014), using generative software to automatically place motifs in a non-repeating tossed pattern with digital parameters in place to ensure a successful composition.

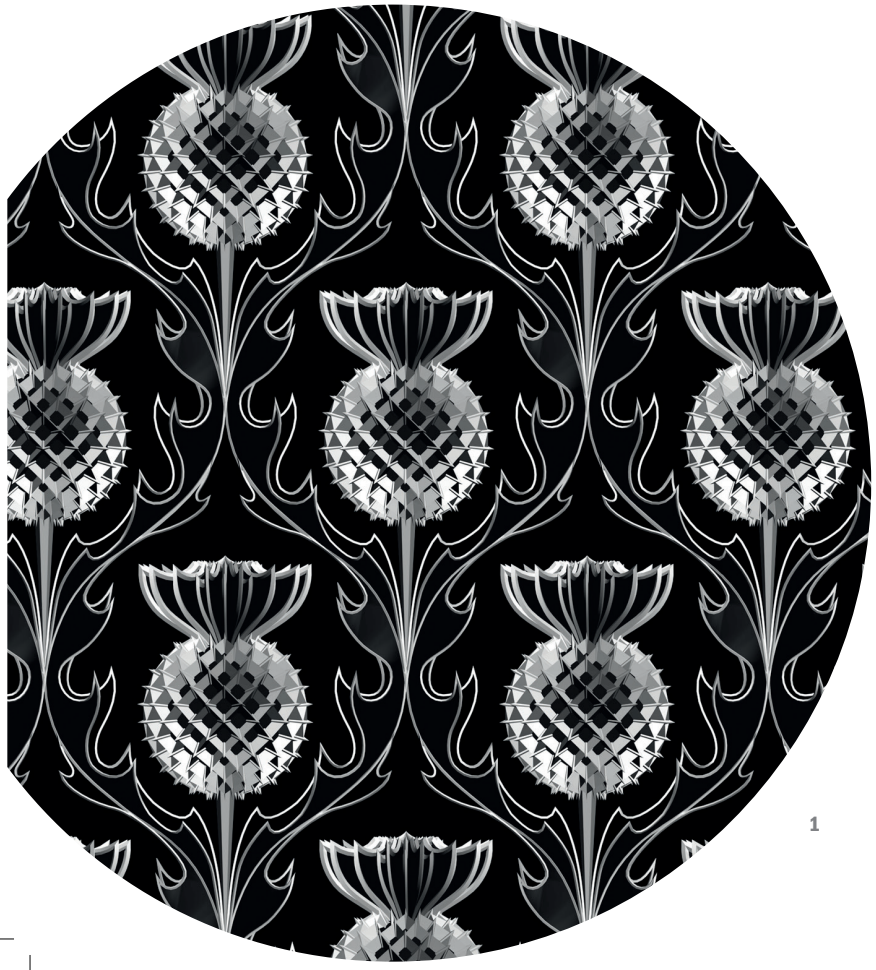
Guided by previous experience in design and production for screen and digitally printed textiles, the following three design projects by the author explicated in this paper explore digital design and production technologies for the development, fabrication and presentation of repeat pattern, investigating perception and experience of scale, form and space through

physical and virtual means. The first, *Biohazard* (McLeod 2011), seeks to promote traditional textile pattern in digital media, and was borne from dissatisfaction with the experience and outcome of designing for digital print production in comparison to hands-on screen-print design. The second work, *Micro-Inhabitation* (McLeod et al. 2012), embraces the immersive and interactive possibilities of digital media through collaboration and exhibition; and the third, *Staurosira Construens* (McLeod 2014), returns to tangible but non-traditional materials to highlight technical aspects of repeat pattern construction with pattern motifs laser cut and etched in acrylic, then lit with LED for exhibition. All three works increased both the author's skills and knowledge of digital technologies, and of printed textile design repeat pattern styles and methods.

BIOHAZARD, 2011

Biohazard (McLeod 2011) is an animated repeat pattern for projection as a digital 'wallpaper' that explores and promotes traditional textile pattern through digital media (figure 1). It is constructed of a recurring stylised thistle motif, the national flower of Scotland, developed in response to a call for entries for the *Powerhouse Museum's Lovelace* exhibition, in Sydney, Australia for lace designs representing the maker's origins or sense of place.

I had recently moved to New Zealand for work and had learned of the country's stringent biosecurity rules regarding plant matter, hence the name, *Biohazard*. While the imagery represents my Scottish roots, the repeat pattern indicates my background in screen-print, and its immateriality relates to aspects of homesickness, as explained later in this section.



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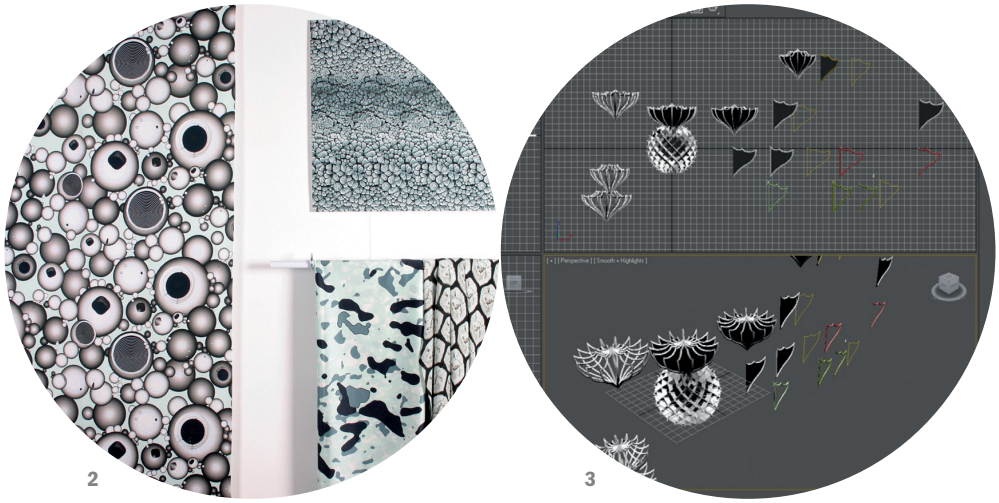
DIGITAL MEDIA AND TECHNOLOGIES PROVIDE AN ALTERNATIVE PLATFORM FOR THE CREATION AND DISSEMINATION OF PATTERN DESIGN, ENCOURAGING EXPLORATION OF MOVEMENT, SCALE, SPACE AND INTERACTIVITY.



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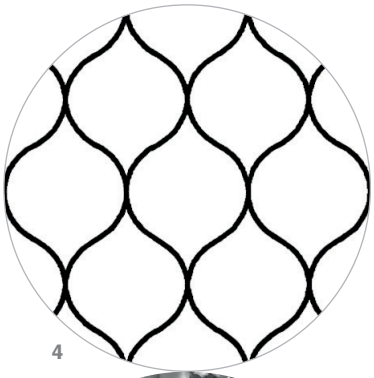
The design was modelled and animated using *Autodesk 3d StudioMax (3ds Max)* software, designed for use by game, film and motion graphic artists. I had previously used the same software to generate imagery for digital textile print (figure 2). In these older designs I produced geometric forms that I could model through the software with ease, and they had an obvious computer generated aesthetic. Briggs and Bunce (1995: 189) identify that, 'In approaching a CAD system, time is needed to explore and 'play', to get through the 'learning curve' before the user can begin to design 'through' the medium.' With Biohazard (McLeod 2011), now that I had more experience of the software, I sought to take more control to generate stylised organic forms in a more complex repeat network.

The generic design software *Adobe Photoshop* is commonly used in screen-print design. Like most textile designers, I find it simple and intuitive to use, perhaps because it can be used in layers, correlating with the screen-print process. In contrast, I find *3dsMax* complex and time-consuming to operate, and its many functions and capabilities overwhelming. Drawing virtually in three-dimensions, as shown in figure 3, is a very different experience to drawing shapes or suggested forms in two-dimensions. Rather than suggesting form from one perspective by adding tone, shadow or planes, with *3dsMax* I had to build the forms from the inside out, with consideration from all viewpoints. To prevent myself from becoming lost in the possibilities of the software, I opted to impose parameters on the design process, using a monochrome colour palette and a limited number of modelling functions, giving direction to the design and increasing my competence with certain tools and effects.

I developed the design as a single thistle motif arranged in an ogee (or ogival) repeat layout (figure 4), by hand and in Adobe Photoshop before further developing and modelling it in *3dsMax*. As in traditional areas of decoration, the planning of repeat and motif was fundamental to the design, and essential before beginning the painstaking virtual modelling process. Art historian James Trilling (2001: 7) explains: '... in traditional ornament, visual effects rarely happen by accident. Ornament is labor-intensive; why should the artist embark on a difficult and time-consuming project without a good idea of what it should look like?'. Developing the thistle motif for an ogee layout gave me confidence that the design would be successful overall. The ogee repeat pattern provided a layout to work within and test, and is a key structural and aesthetic element of the design:

> *Whatever its origins, for more than thirteen hundred years the ogival pattern has provided textile designers with both an anchor in tradition and a stage for innovation... However elaborate the individual motifs, the strength of the ogival pattern has always been the pattern itself, the balance of parts and whole.*
>
> *(Trilling 2001: 130)*

The stylised leaves of the thistle motif make up the ogee framework; the outer leaves of one column of motifs act as the inner leaves of the next, inspired by the recurring twisting Acanthus motif in William Morris' 19th century tapestries



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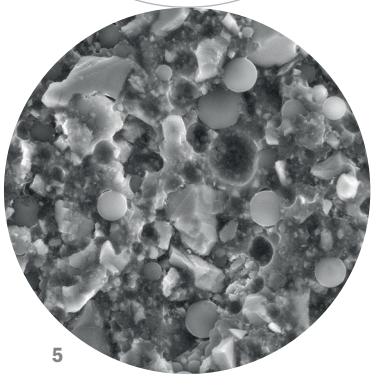

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and block prints. In the resolved design the leaves serve as a stationary lattice, supporting the crowned thistle heads, which are centred in the negative space between the leaves and are animated to revolve slowly on the Y-axis, displaying their three-dimensional form more effectively.

The decision to develop this pattern for animation and projection, rather than digital print on fabric, stemmed from my dissatisfaction with my previous experience of designing for digital print. In contrast to the hands-on processes I would go through to design and produce a screen-printed design (drawing, mark-making, preparing and exposing a screen, mixing the dye paste and printing, fixing onto fabric) I found the experience of generating imagery through software on a monitor and having the design digitally printed to be sterile and unrewarding. The digital technology disconnected me from the design and making process and materials. I identified with textile artist and writer Susan Brandeis' (2004: 45) reflection on her experiences of working with digital processes: 'I have yet to find the kind of satisfying 'dialogue' with the computer that I have with simpler tools and fabric.' I was also not content with the results of digital printing on fabric: the density of colour and solidity of edge that could be achieved through digital print was less intense than what I was accustomed to with screen-print. Nor did digital print achieve the sharpness of edge or density of solid colour that displayed on the computer monitor. By resolving the design as a projection rather than a digital print on fabric the pattern could retain its sharpness and depth as well as maintaining motion.

At that time it was disconcerting for me as a textile designer to produce a work that I could not handle or drape. I found this correlated with my growing homesickness, linking it to the feeling of detachment and alienation that I experienced communicating with my family and friends in the UK mainly through email: disconnected, intangible, there but not there. *Biohazard* (McLeod 2011) was designed for projection at 2.67m x 2m, but is rendered and animated so that it can be projected multiple times to fill greater expanses. Despite the potential to be shown on a large scale, digital projection is ephemeral and impermanent; Jakob (2008: 256) refers to '…a pleasure gained from observing oneself and the surroundings becoming harmlessly and momentarily transformed.' *Biohazard* (McLeod 2011) subtly introduces virtual form and motion to the ogee pattern framework, promoting aspects of traditional repeat pattern through the informed use of digital tools and media. The transformation of architectural forms and spaces through digital media projection and projection mapping provides growing opportunities for designers with knowledge of design for printed textiles to develop and show works advanced by digital technologies, as in the next work discussed, *Micro-inhabitation* (McLeod et al. 2012).

MICRO-INHABITATION, 2012

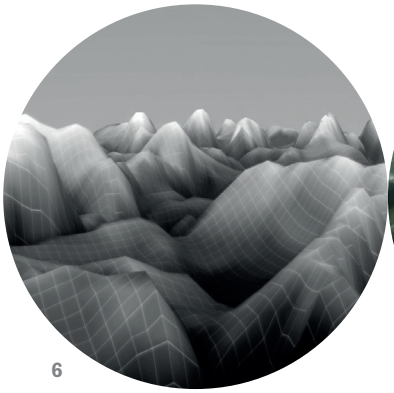
Whereas *Biohazard* (McLeod 2011) is viewed on a plane, *Micro-inhabitation* (McLeod et al. 2012) is an interactive, immersive experience allowing the audience to enter into and navigate a virtual three-dimensional pattern, as if entering street view in *Google*

Maps but at an anthropocentric scale. Introducing the 2011 exhibition 'The Pop-Up Generation: Design Between Dimensions' curator and trend forecaster Lidewij Edelkoort (2011: unknown) explains how ubiquitous technology is affecting the way people perceive and understand space:

> *Young generations born with and behind the screen live in a shadow area, a no man's land between the second and third dimension that they wish to connect. This Pop-Up Generation moves easily from 2D to 3D and back again as if they do not even notice that there is a difference.*

In collaboration with spatial designers Stuart Foster and Oliver Blair, *Micro-inhabitation* (McLeod et al. 2012) seeks to communicate the experience of scanning electron microscopy, primarily the preserve of the scientist, as a human experience through digital creation and manipulation of pattern, form, scale and perspective. The subject matter, or rather the matter under the microscope, is a fleck of paint (figure 5) from the Form Gallery, Perth, Australia, where the work was shown as part of 'An Interior Affair: A State of Becoming', an Interior Design/Interior Architecture Educators Association (IDEA) exhibition, allowing the audience to identify and relate the microscopic imagery to place.

In 'On Longing: Narratives of the Miniature, the Gigantic, the Souvenir, the Collection' Susan Stewart (1993: 44) describes Hooke's 1665 'Micrographia' as 'a display of a world not necessarily known through the senses, or lived experiences.' Hooke rendered what he saw through the lens of the microscope with ink on paper.



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When Stuart Foster and I operated the scanning electron microscope with scientist, Dr Ruth Knibbe, the microscopic image was displayed on a computer screen. Focussing, increasing or decreasing magnification, moving the sample, and focussing again allowed us to journey into this world and discover new detail, form and texture, and to capture it as digital image files. The miniscule had become gigantic, a never-ending landscape. Technology enabled us a closeness and connection to a world that otherwise we would have never encountered.

It was this experience that we sought to recreate and share through the interactive exhibition piece, allowing the audience to enter into the microscopic realm of the material of the gallery. To make the infinite pattern the basis of the continuous landscape design I blended together several scanning electron micrographs (SEM) and then created a repeat tile with *Adobe Photoshop*, using techniques for the creation of seamless repeating patterns for digital print. Seamless or textured repeats are a key design method and aesthetic of digitally printed patterns whereby complex tonal imagery is manipulated digitally so that it can be repeated as a continuous image without discernible joins. I took care to create a balanced pattern with no obvious 'tram tracks' (unintended prominent features in a repeat unit, which when laid out create a noticeable interruption), disturbing the rhythm of the design. The two-dimensional, tonal pattern was then translated using *Cryengine*, a gaming engine software for the creation and development of video games, transforming the two-dimensional image into virtual three-dimensions (figure 6). A path into and through the virtual landscape was recorded using the same software. What I did not predict was that as the route was recorded through the design a new type of 'tram track' was produced, where elements of the design stood out from a wandering ground level perspective as seen in figure 7, highlighting the need to consider three-dimensional pattern form from multiple perspectives.

Interactivity for the audience of the installation was introduced through the integration of hacked *Nintendo Wii* gaming technology, making the speed and direction of the large-scale

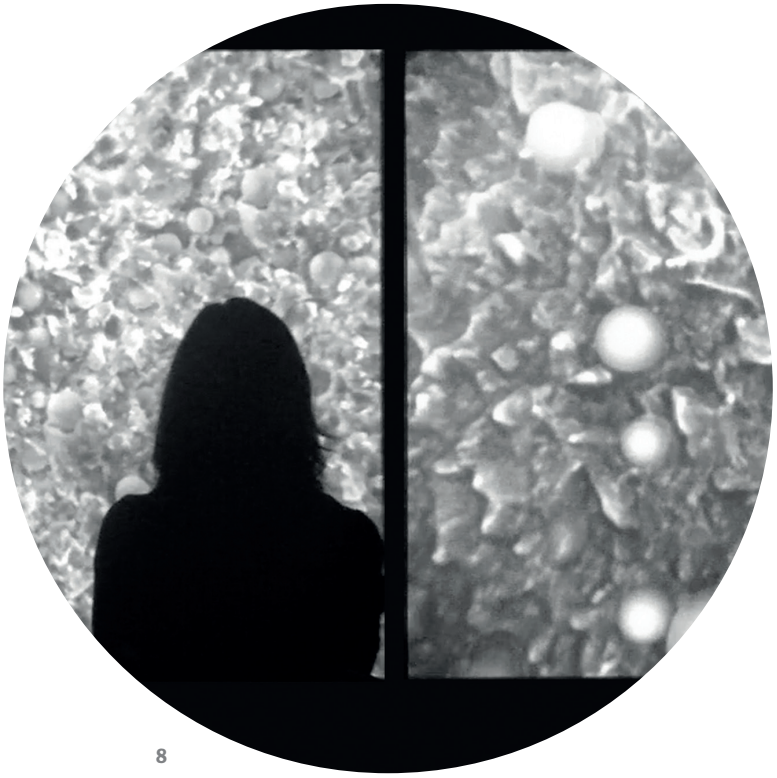
projection responsive to the proximity of the participant. The scale of the projection was designed so that it could be viewed in entirety from initial approach, but as the viewer approached it would fill their field of vision. Figure 8 shows installation views at various points throughout the projection: users survey the terrain from above before zooming in and entering the environment at 'ground level'. The installation is an immersive realisation of a repeat pattern that can be entered and navigated virtually, exploring scale, form and perspective in space and time. Reviewer, Mary Anne Beecher described:

> *Because the animation of the project is triggered by the movements of participants, both the imagery of space and its literal creation through the establishment of a link between the moving image and the body become immersive in ways that simple acts of observation cannot. The experience of this relationship raises important questions about potential new ways in which technology may contribute to the creation of activated interior spaces and surfaces.*
>
> *(Beecher 2013: 353)*

Whereas part of what drove *Biohazard* (McLeod 2011) was my concern about the impact of digital technologies on the experience of print design for designers, the impetus for *Micro-inhabitation* (McLeod et al. 2012) was the urge to communicate the experience of microscopy to an exhibition audience. *Biohazard* (McLeod 2011) is a pattern viewed on a plane as any wallpaper is; *Micro-inhabitation* (McLeod et al. 2012) allows the audience to experience pattern in four-dimensions through immersive, interactive design.

STAUROSIRA CONSTRUENS, 2014

Staurosira Construens (McLeod 2014) is a large-scale laser cut and Light Emitting Diode (LED) lit acrylic pattern designed for exhibition as part of Lux, *Wellington Nightlights Festival* 2014, New Zealand, a public light festival on Wellington's waterfront featuring works that celebrate light, art, design and technology. The imagery featured in the design is derived from scanning electron micrography of diatoms, minute photosynthesising algae found in fresh and saltwater (figure 9). In contrast to the continuous texture of the paint fleck micrographs featured in *Micro-inhabitation* (McLeod et al. 2012), microscopy of the diatom samples revealed a different type of landscape. At high magnification it showed individual complex geometric structures whilst at a lower magnification it displayed the forms piled and scattered like debris washed up on a shoreline.



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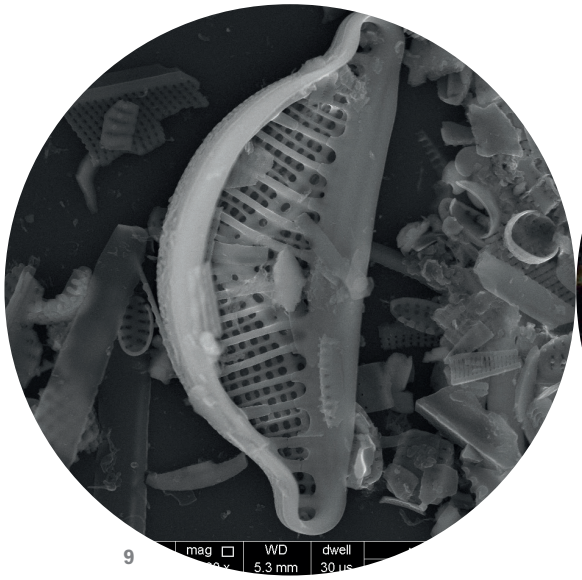

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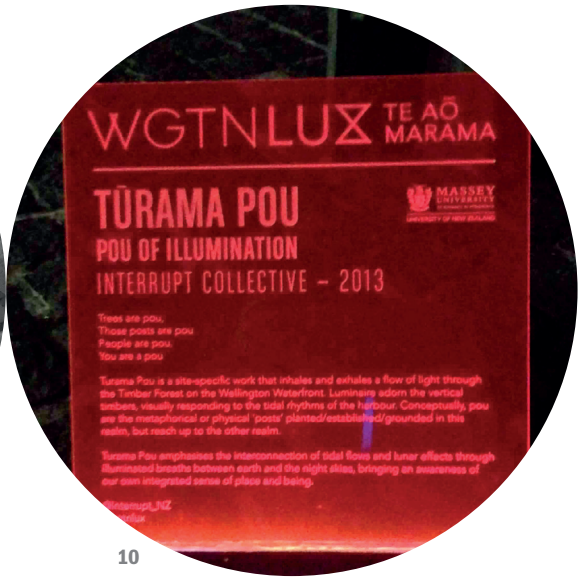

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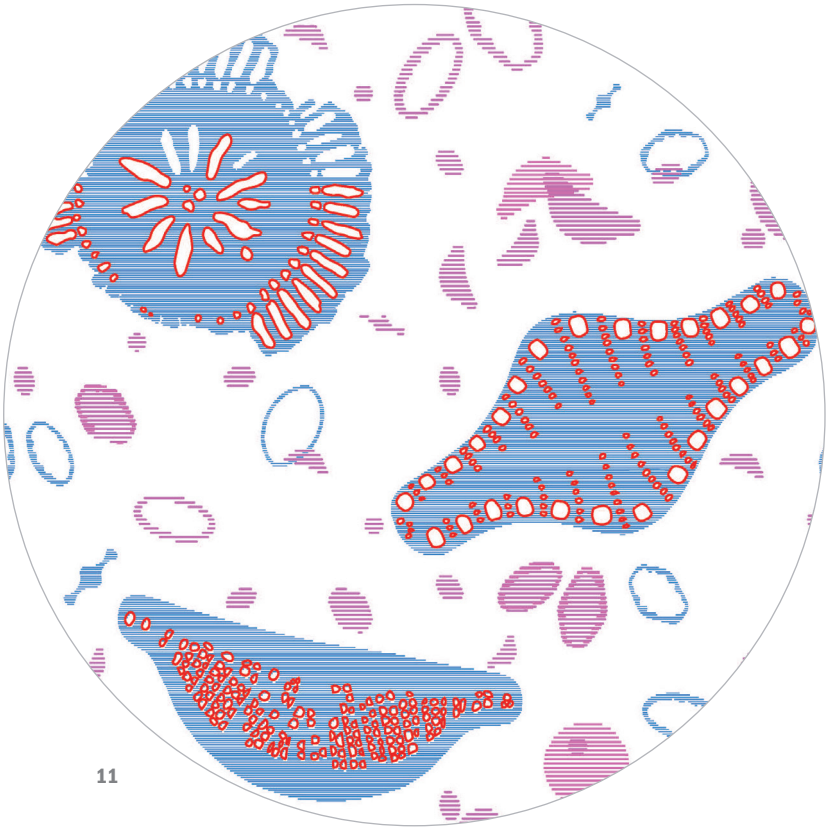
In *Staurosira Construens* (McLeod 2014) I sought to capture and reveal the unusual geometry of the diatoms, and to represent a sense of their arrangement in space as I found them under the microscope.

With this work I wanted to highlight repeat textile pattern in unexpected materials, and also to increase my experience of laser cutting. This use of technology and materials was informed by Christopher Pearson's 2007 LED lit, laser etched glass panel installation, Oak Seasons, and Stuart Foster's raster etched acrylic signage design for Wellington Lux 2013 (figure 10).

To generate a scanning electron micrograph the microscope scans a beam of electrons across a surface from side to side in a raster pattern. The microscopic surface is displayed on screen as a greyscale tonal image. The greater the curve of a microscopic surface, the brighter it appears in the image generated. These micrographs provided me with visual inspiration for motif and pattern arrangement, and the varying levels of brightness informed my use of the laser cutter power and speed settings to create areas of greater and less intense light.

When laser cut acrylic is lit with LED the deeper the cut, the more light escapes and the brighter the cut line appears. The laser cutter has two cutting functions: raster and vector. Raster images are pixel-based and are generally used for etching areas rather than lines into a surface. The depth of the cut is controlled by the tone of the image, and the power and speed settings of the laser: when reading the image, the darker the pixel, the deeper the laser will etch. My diatom images were raster images, however laser cutting raster images is a slow operation, and was not an option for my large-scale installation. Vector images, such as those generated through *Adobe Illustrator*, are based on points and paths. When reading a vector file the laser starts on a point and cuts in a continuous line or curve until the endpoint of the path. The depth of the cut is dependent on the power and speed settings of the laser and the laser can be set to cut completely through the material or to etch the vector line. Using this faster option for cutting and etching the pattern design meant that I had to re-interpret and stylise the diatom structures as motifs, rather than using the micrographic imagery directly, making the influence of printed textile design more apparent in the final design. Figure 11 shows the cutting plan for the design: the red line represents complete cuts through the acrylic; the blue a mid-depth etch; and the pink a shallow etch.

In screen or rotary printing, linework can be used to create depth and tone in a one-colour print, which is cheaper to produce than a multi-coloured print (Meller & Elffers 1991). Informed by this method, I further reduced cutting time for the design by simplifying tonal



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REPEAT PATTERN KNOWLEDGE FOR PRINTED TEXTILE DESIGN CAN GUIDE AND ENRICH THE USE OF DIGITAL TECHNOLOGIES AND MEDIA FOR INNOVATION IN REPEAT PATTERN DESIGN, FABRICATION AND PRESENTATION.

detail to hatched linework. Varying the spacing of the lines and the depth of cut allowed me greater variety in tone. After testing I limited the direction of the linework to solely horizontal, as the laser ran more smoothly and had to travel less distance running on the X-axis, improving the sharpness of the lines and again reducing cutting time. Each panel formed one repeat unit and took 50 minutes to cut.

Figure 12 depicts the layout of the motifs within each repeating unit. Large motifs are arranged in a traditional three-spot repeat layout (figure 13), commonly used to create multi-directional spaced designs, with smaller varied motifs arranged in a continuous scatter beneath. The layout of the large motifs creates the overall rhythm of the design and the background layer adds depth and interest, as a patterned ground would, for example, in a screen-printed floral design (Meller & Elffers 1991).

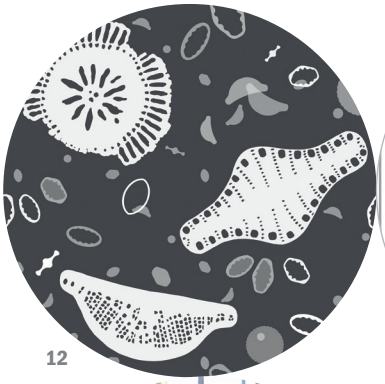
Staurosira Construens (McLeod 2014) is constructed of sixteen laser cut and etched Plexiglas Endlighten acrylic panels, suspended in aluminium channels, which conceal strips of LED. This rigging was refined and constructed by industrial designer, Michael Jones. The design of the work evolved in response to the installation site, a full height, glass-panelled corridor of the Museum of Wellington

City and Sea, now Wellington Museum (figure 14), which both defined and displayed the full drop layout of the repeat unit. The 64cm etched and cut square panels work within the dimensions of the window framing to fill them with pattern. The framing served as vertical breaks between the panels, and the aluminium channels in which the LED strip and acrylic panels sat provided horizontal breaks in the design. The resulting grid emphasised the repeat structure that would usually be hidden in a printed textile design of this style. The two-sided glass corridor reflected the design repeatedly behind itself, creating an additional level of depth. The installation, as seen in figure 15, literally highlights printed textile repeat design pattern methods through alternative technologies and materials, and suggests opportunities for laser cut repeat textile pattern on hard materials as lighting and as interior and exterior panels. The design shows captured microscopic imagery engraved at a large scale in a spaced repeating pattern, drawing attention to the individual motifs, but also hinting at a world of structures and patterns still to be discovered at other magnifications.

CONCLUSION

Rapidly emerging and evolving digital technologies disrupt traditional design methods and break down disciplinary boundaries. They enable new ways of designing and making, and provide designers with alternative materials and modes of presentation for their work. This paper has demonstrated how repeat pattern knowledge for printed textile design can guide and enrich the use of digital technologies and media for innovation in repeat pattern design, fabrication and presentation.

Biohazard (McLeod 2011) shows how animation and modelling software can be used to generate imagery for pattern, and how animated pattern can draw the attention of new audiences to the value of traditional repeat pattern construction methods. *Micro-inhabitation* (McLeod et al. 2012) presents repeat pattern in three- and four-dimensions allowing the audience to interact with microscopic pattern in virtual space and time, in line with society's changing expectations of immersion and interactivity driven by ubiquitous computing. In contrast, *Staurosira Construens* (McLeod 2014) provides a still moment to appreciate the underlying framework of repeat pattern, drawing attention to use of line, motif and composition. All three works demonstrate investigation of digital technologies and highlight how the application of parameters, as seen in the evolution of printed textile design, can guide and drive their use: exploring new ways to generate and experience pattern: physically and virtually; static and in motion; in time and space.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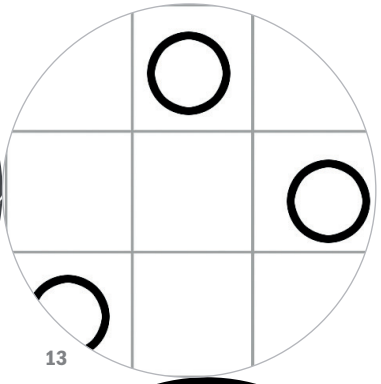
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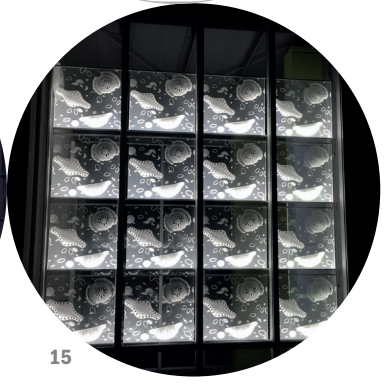
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