Northumbria University, Newcastle.
Art and Design: History, Practice and Theory. UoA 32.

Northumbria University
NEWCASTLE

HAND THOUGHT
CRAFT VALUES IN DIGITAL MAKING

Exploring the aesthetic opportunities that computer numerically controlled technologies can hold for the craft maker.

Type of output:
Collection of
Creative and
critical work

by
Justin Marshall

CONTENTS

Northumbria University NEWCASTLE

SUMMARY

This series of CNC milled/hand carved wood tableware and digital/analog drawings was developed, between 2018 - 2020, to explore both the aesthetic opportunities that CNC (computer numerically controlled) technologies can hold for the craft maker, and to question where the line between hand and machine-made lies. More broadly it seeks to both explore and demonstrate craft approaches and values when engaging with digital production technologies.

The research aims were to:
- Investigate the aesthetic opportunities that CNC technologies can hold for the craft/designer maker.
- Demonstrate a crafty (in contrast to designerly) approach to the engagement with digital tools embodying a Pragmatic approach to, and consideration of, mediating technologies.
- Use the resulting work as a springboard to instigate debate concerning how the creative use of the digital tool-set can challenge the concepts/values of craft and the 'handmade'.

This research builds on previous work carried out by the researcher, (e.g. within the Autonomatic research group 2003-2014), and others from this group and beyond exploring both aesthetic opportunities of digital tools: e.g. Masterton (2007), Jorgensen (2013), Zoran (2015), Johnson (2017), Gareth Neil (2015), Grimshaw (2017), and it's significance: McCullough (1996), Pallasmaa (2009), Ingold (2013).

The work was created using various configurations of CAD, specialist toolpath software, CNC milling, smart pen, a plotter, hand drawing and traditional wood carving techniques. A number of the 3D artifacts were used within workshops that sought to explore broader craft values in digital making. As such this body of work sought to combine a sophisticated digital making/hybrid practice (as an end in itself) with an explicit investigation into associated theoretical debates.

This body of work has been disseminated at research focused events: Handmade by Machines, symposium and exhibition, Birmingham City School of Jewellery in 2019, and the 2019 RTD conference, in association with the co-authored paper *'Enticatypes: Exploring how artefacts can entice conversation on craft values in digital making'*. In addition, it has been exhibited at Gallery North, as part of Great Exhibition of the North, Newcastle in 2018, and as part of *Baltic Open*, The Baltic, Gateshead, 2021.

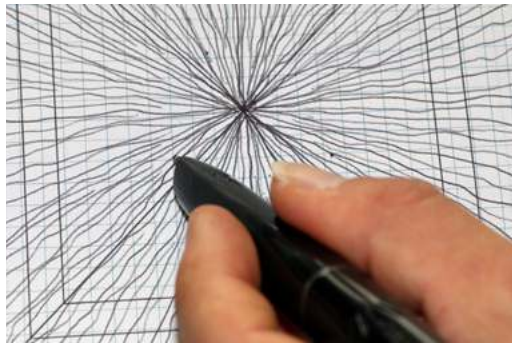
Below: Bowl, Platter and Dish
from the Ambiguity Series, 2018.

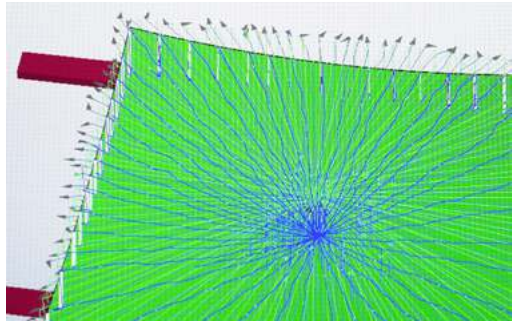
RESEARCH CHALLENGE

Considering tools not as neutral means to an predefined end, but as active and constructive elements within the creative making process, a Pragmatic understanding of technological mediation provided a foundation for thinking and making in this project that explores and celebrates tools, (both material and immaterial), in a crafty way. In seeking to make a distinction between a craft and a design approach to making this work sought to demonstrate a digital craft attitude that has characteristics that can be overlooked and/or undervalued in other established digital design and manufacturing practices. These include aspirations for:
fidelity *not* accuracy, sensitive making *not* efficient manufacturing, to augment existing practices *not* replace established ways of working, celebrating and revealing materials and processes *not* making manufacturing procedures imperceptible, uniqueness not infinite replicability, and continual 'hands-on' interaction with tools *not* full automation.

Aims:
- To investigate the aesthetic opportunities that CNC technologies can hold for the craft/designer maker.
- To demonstrate a 'crafty' approach to the engagement with digital tools which embodies a distinct approach to, and consideration of, mediating technologies.
- To use the resulting work as a springboard to instigate debate concerning how the creative use of the digital toolset can challenge the concepts/values of craft and the 'handmade'.

Objectives:
- To create a series of wooden tableware, and accompanying drawings, combining analog and digital input and output techniques.
- To undertake workshops that utilize these works within the context of exploring concepts, principles and values of craft and the handmade in the context of digital making technologies.





Top left: Smart pen drawing capture.
Left: Drawing conversion into digital toolpath.

CONTEXT

Within Marshall's own research practice see, (e.g. Autonomatic research group 2003-2014), this body of work continues his interest in investigating the aesthetic opportunities offered by digital technologies, alongside considering the role and significance of technological mediation within craft practice.

It also sits in a wider context of other practitioner and researcher activity in the area of digital craft/making (see Johnson, 2017) and the associated debates concerning, value, authenticity, handmade, craftsmanship and skill. For example, *Hybrid craft*, as one way of defining a combination of digital and analog practices, as deployed in the production of this work, has been showcased and discussed by Zoran (2015), who included previous work by Marshall in his curated exhibition at the Siggraph conference in 2015. Work by other practice-based researchers has used aspects of the technical approach taken in this project, for example, the use of CNC milling for the creation of surface pattern for ceramics (see Bunnell in Zoran (2015)) and the exploration of toolpath software as a creative realm by Masterton (2007) in producing one–off metalwork pieces. In addition, Jorgensen (2013) has explored the capture of hand gesture to create unique glassworks. Most recently Grimshaw (2017) has documented the use of CNC milling in the production of wooden tableware pieces. However, the bringing together of the particular techniques and materials used in this body of work is unique to the field.

The proposition embodied in this work is that in order to both reach and engage an audience of craft and design practitioner-researchers in debates of potential relevance there needs to be a commitment to the creation of physical work that displays a level of visual sophistication and resolution (i.e. the value of the debate is validated through the design outcomes it has inspired). This work is distinct from other research, for example Devendorf & Rosner, (2017), who use design propositions rather than actually making physical objects as a way to interrogate notions of hybrid craft. Other researchers use 'lo-fi' prototypes to investigate this area, which while providing a route to rapidly explore ideas through making practices, often appear to have little regard or interest in the physical characteristics of the final objects resulting from the practice (e.g. Devendorf & Ryokai, (2015) and Kim et al (2017)). Conversely, there has been significant research work undertaken exploring the aesthetic opportunities that the use of digital technologies hold and CNC in particular (e.g. Masterton 2007, Neil, 2015). However, this sophisticated and resolved work has not been used specifically as a focus for reflection on the wider implications of hybrid making, craft values and associated debates. Therefore, this research seeks to bridge these two approaches by taking the results of practice seriously as outcomes in-themselves, while also recognising that they need to be put to work in a context in which they can help elicit discussion concerning underlying theoretical debates.

On a broader level, this area of digital craft research can contribute to the wider exploration of our relationship with technology in the context of recent debates concerning the rapid developments in automation and machine learning, and their impacts on the future of work.
If we measure the value of all technologies/tools exclusively on their productive efficiency, their speed, their ability to achieve predetermined goals, and make production systems increasingly invisible and 'black box', then questions arise: What is the future role of physical productive human engagement with the world? Can alternative visions of our relationship with technology be promoted and demonstrated?
What is the future of making and what might it look like?

METHODS AND PROCESSES

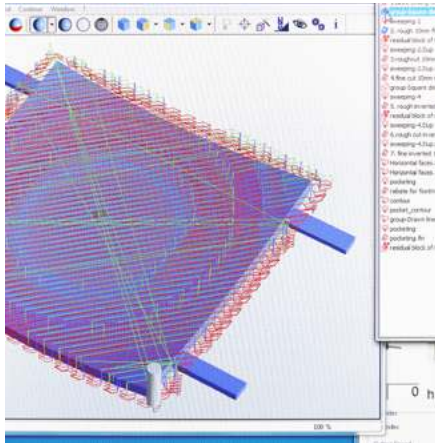
The Ambiguity series.

The approach to this project is framed by the proposition that **digital production technologies are translational rather than reproductive** (i.e. they do not simply reproduce virtual designs, but play an active and essential part in the characteristics of the final physical forms).

The use of CNC milling machine as a digital production technology was selected for this exploration as it provides, in contrast to the increasing 'locked down' and inflexible offerings within the commercial 3D printing sector, a wide degree of freedom and opportunity for experimentation (i.e. material selection, cutting tool shape and size, toolpath creation, tool and cutting speeds).

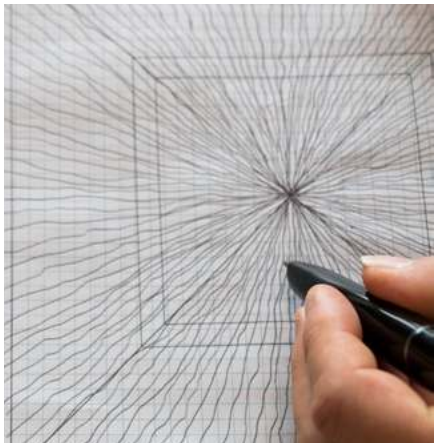
As a material, hardwoods that have traditionally been used in hand carving and turning have been used (i.e. it is an established 'craft' material). The underlying intention of this particular series of works was to create work that had ambiguous surface characteristics; **combining and contrasting analog and digital aesthetics**, while using an entirely digital means of production. This was achieved by contrasting a seemingly hand carved top surface with an explicitly digitally generated and cut underside.

Three axis CNC milling machine used for all production.



Mayka toolpath software,
(note: the list of numerous different cutting regimes and tooling parameters.)

Fine cutting the top surface.

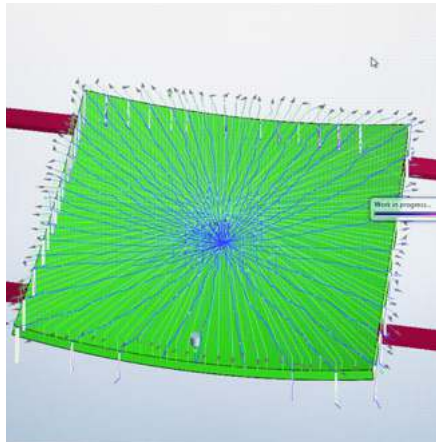


Anoto pen used for analog drawing.

Using some form of analog input (i.e. hand drawn) was a key aspect to the project and for this an Anoto pen was used. This technology, developed for physical note taking that can then be uploaded to a digital device, allows physical drawing to be captured in a vector format and so used to generate toolpaths with no loss of fidelity/detail. The use of this novel approach creates hybrid surfaces which are not easily categorized as digital or analog.

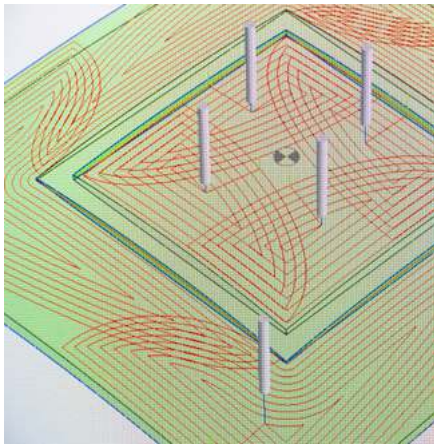
In contrast, the underside surface of the pieces exploit and celebrate the software that generates toolpaths to create complex surfaces patterns and textures. My approach explicitly subverts the software's mission to create optimum toolpaths to efficiently reproduce CAD designs. Amongst a range of other techniques, deceiving the software through mismatching settings with the actual tool shape and sizes used, **a visual language can be created that is clearly digital in origin and is rooted not in predetermined design work, but is borne out of the mediation of the technologies** used (both hardware and software).

The use of this novel approach creates hybrid surfaces which are not easily categorized as digital or analog.



Drawing converted into a tool-path for milling.

Milling machine accurately reproducing hand drawn lines.



Surface patterns created through software optimisation of tool-paths.

Underside of dish with milled surface pattern.

The Ambiguity series: Outcomes.

Four pieces of tableware were created; each utilized the hybrid hand drawing method described previously on their top surfaces. Their undersides were used to explore the range of surface textures and patterns that can be created through varying the parameters within the toolpath software (i.e. Marshall did not design the patterns themselves, but controlled the way in which the software calculated optimum cutting regimes to generate the final designs). Thus, **the work seeks to embody natively digital design with a hybrid analog/digital approach**.

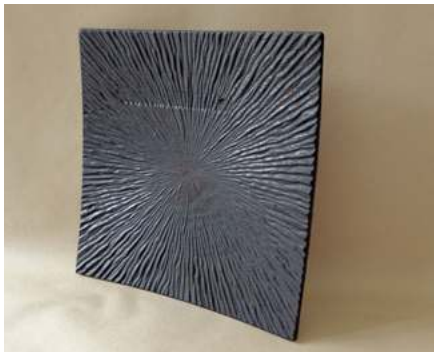
1: Square platter, 290x290x25mm,
CNC milled, rust stained oak

2: Small bowl, 210x45mm,
CNC milled rust stained oak

3: Oval dish, underside,
370x260x60mm,
CNC milled, rust stained oak

4: Oval dish, 370x260x60mm,
CNC milled, rust stained oak

1.



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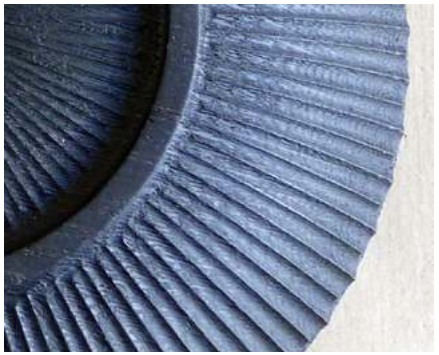


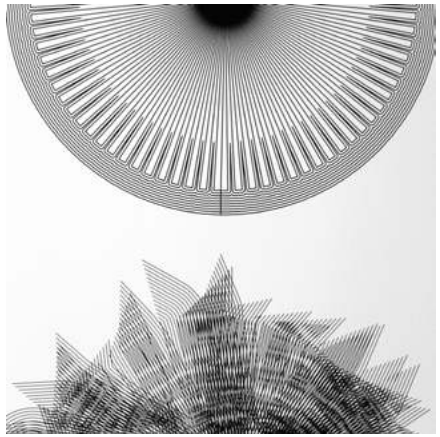
3.

4.

Digital drawings exploring the visual language of optimization.

A set of digital prints accompanies the milled pieces. The imagery is based on the toolpaths generated by the software to control the CNC milling machine for each of the pieces. **The intention was not to create direct illustrations but to explore the visual language that the software generates** in its mission to optimize the paths that the cutting tools will follow; in part attempting to resolve the 'inaccuracies' of the analog hand drawn elements into geometrically perfect straight lines and arcs. In utilizing and celebrating this tension between the analog and the digital these drawings contribute to the wider concerns of this body of work.

1.



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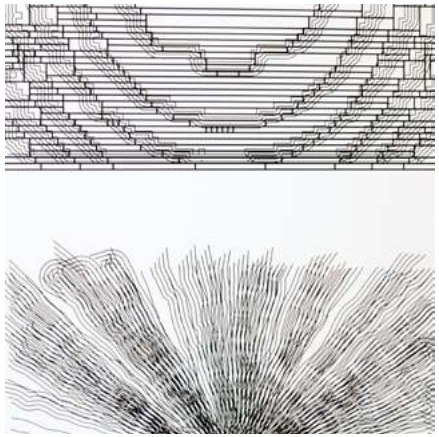
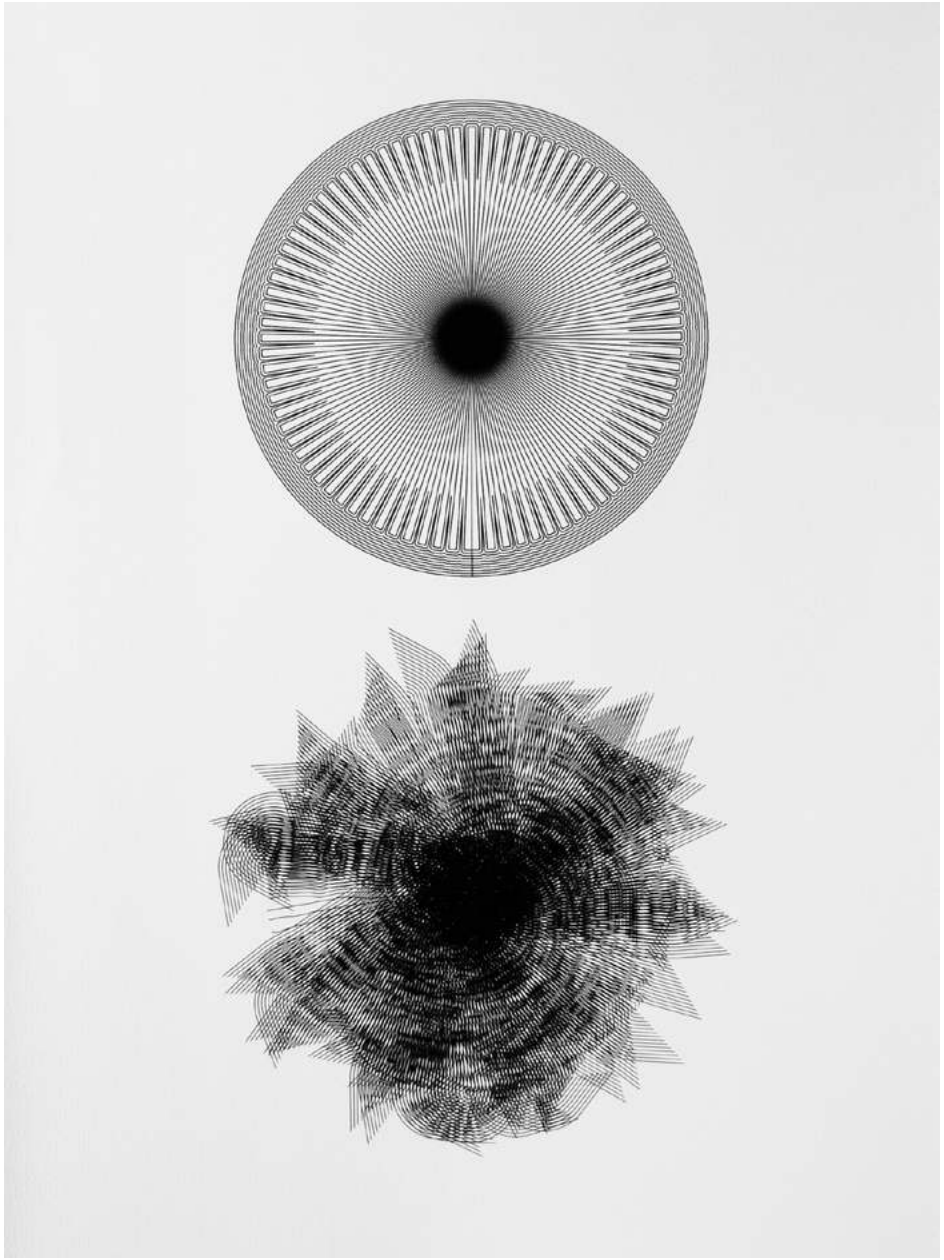


1: Drawing on Small Bowl, detail.
2: Drawing on Square Plate, detail.
3: Drawing on Small Bowl,
A1 Digital print.

3.



METHODS AND PROCESSES

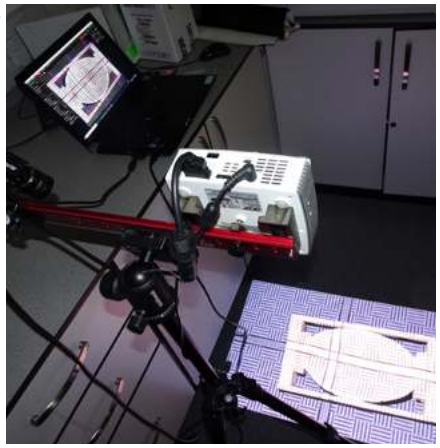
The Interference/integration series.

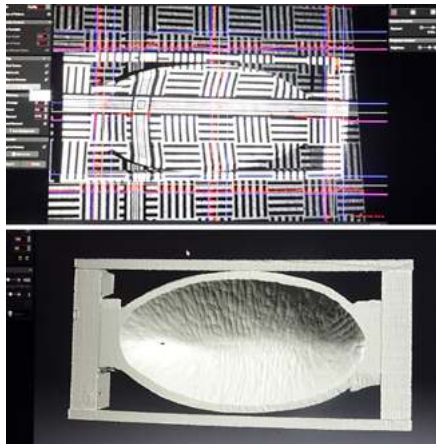
In contrast/as complement to the previous series, these wooden bowls/ tableware, and associated digitally augmented hand painted watercolours, don't seek to be ambiguous about their making processes. They explicitly combine established handcrafting techniques (i.e. hand carving and painting) with digital production processes (i.e. CNC milling and plotting) to create truly hybrid analog/digital artefacts. Through these works Marshall sought to create a conversation between hand carving and milling and began to articulate a language that is recognized as distinct and is neither quite (hand) made or (machine) manufactured.

Within the 3D pieces this aspiration led to a new work flow that was more complex than used in the previous series and required an extended timescale and pace, necessitated a greater attention to the natural irregularities of the materials used, and embodied risk at more points along the whole making process.

1. 

2. 

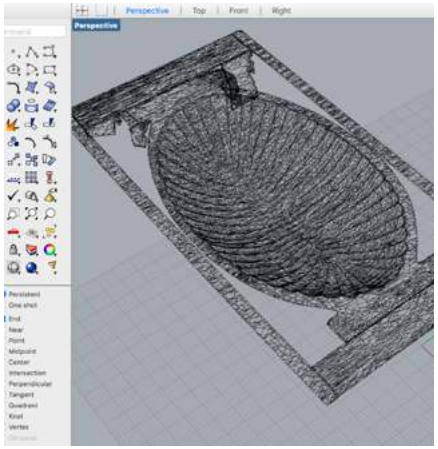
3. 

4. 

1. Traditional green wood tools and techniques used to carve bowl forms.
2. 1st stage completed bowls are dried left to slowly dry to season the wood.
3. Bowls are scanned using a white light scanner to produce digital models.
4. This scanning process picks up cut marks and other surface detail of the bowls.

While the crafty workmanship of risk (Pye 1968) is still unquestionably present in the early stages of hand carving it does not exclusively lie in this stage of the making process.
The risks that are distinct, and worthy of recognition in this hybrid method, are in the practical and conceptual aligning of the digital with the analog. At this boundary, where the static and unyielding digital world meets the material vicissitudes of living wood (see 3.), there is a negotiation in which aspirations of accuracy, and the reproducibility of a digital form, give way to seeking fidelity and sensitive synthesis.

So, although there are aspects of the digital at play, there are no undos and no option to start over. Each piece is therefore a one-off, bringing together a particular piece of green wood uniquely carved, with a toolpath that maps only onto that form, in a particular way, at a certain point in time.
Assumptions of speed and efficiency in the use of digital tools are confounded by the strategies used here. It is not that there is always a different, and accelerated, pace to a practice that integrates digital technologies, but that the rapid and more time-consuming aspects that make up the composition of the whole design and production process are often re-orchestrated. For example, the 'quick, quick slow' tempo of an entirely handmade process, becomes a 'quick, slow, quick' in a hybrid practice.

1.


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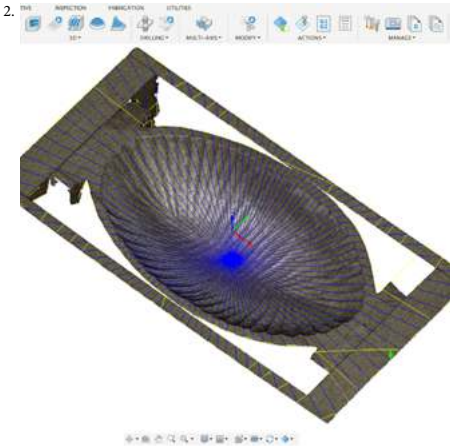

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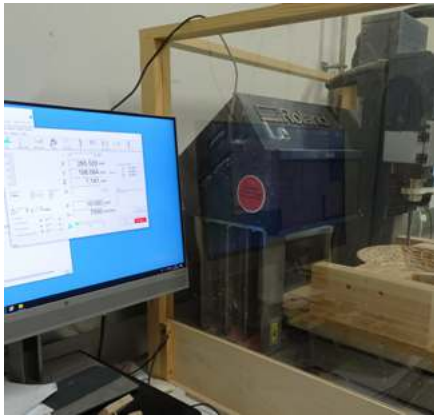


4.


1. The models are mended, scaled, and oriented in CAD.
2. Toolpath are generated that follow the surface of the scanned forms.
3. The origins of the physical bowls on the CNC router are 'aligned' to those in the toolpath software.
4. The router then cuts digitally generated surface patterns onto the bowls following the form of the hand carved original.

The Interference/integration series: Outcomes.

Five pieces of tableware were created in this series (3 illustrated here): each exploring differing combinations of hand carving, tool size/shape and CNC cutting regimes.

1. Long Platter (top), 450x155x45mm hand carved and CNC milled, rust stained oak.

2. Long Platter (underside), 450x155x45mm hand carved and CNC milled, rust stained oak.

3. Arrow Bowl, 420x160x40mm, hand carved and CNC milled, rust stained oak.

4. Round Bowl, 320x260x100mm, hand carved and CNC milled, rust stained oak.

3.

4.

1.

2.

The Interference/integration series:
Surface/texture vocabulary.

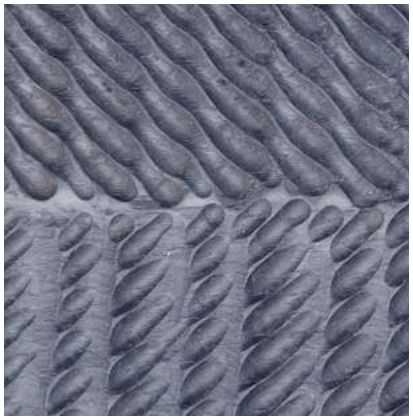
This series of works explores digital and physical mark making, seeking to develop a new hybrid language where there is a synthesis of hand and machine aesthetics.

Some of these examples explicitly show where the hand carved meets the machined, while others focus on how the negotiated misalignment between the CAD model (from which the cutting paths are derived) and the physical form, leads to unique and varied surface patterns and textures across a single piece.









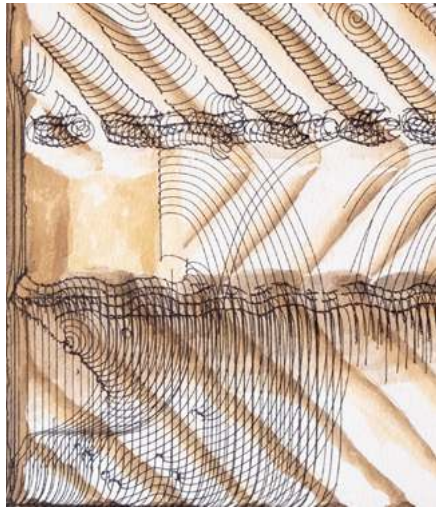

Images: Details of hybrid surfaces and textures from across this series of pieces.

The Interference/integration series:
Hybrid Drawings.

A hybrid drawing accompanies each of the wooden pieces. Like the previous series the digitally plotted imagery has been derived from toolpaths. Through the combination of traditional watercolour processes (entirely in my control) with digital mark making (generated by the software and digitally plotted), this set of drawings seek to find a sympathetic integration of the digital and analog, rather than set up a tension or dichotomy.

1. Long Platter hybrid drawing (detail)
2. Long Platter hybrid drawing (detail)
3. Long Platter hybrid drawing, A1 watercolour+pen plot

1.



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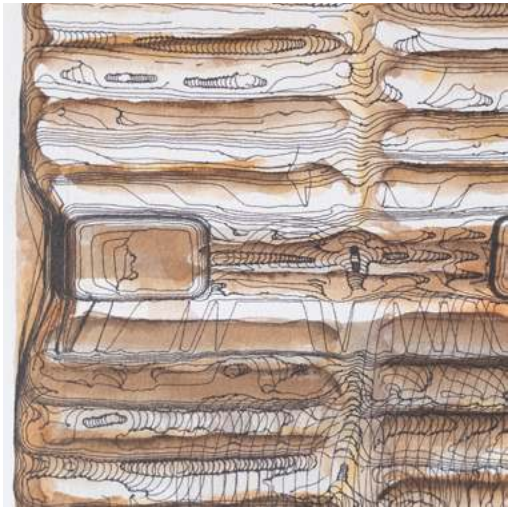

3.

The Interference/integration series:
Hybrid Drawings.

1.

2.

1. Oval Bowl hybrid drawing,
A1 watercolour+pen plot
2. Round Bowl hybrid drawing,
A1 watercolour+pen plot

DISSEMINATION

Great Exhibition of the North, Newcastle: Tableware and Digital Prints. As part of the Great Exhibition of the North (GEOTN), the works were shown at, Gallery North in Newcastle, June 22nd-September 9th 2018. GEOTN was 'a three-month celebration of the North of England's pioneering spirit and the impact of our inventors, artists and designers'. This work was exhibited as part of the Design Trial. Audience numbers of 3.8M were achieved over all events.

'Justin Marshall's work; so intricate, combining elements of the modern and the traditional'

Exhibition at Woon Gallery of Asian Art, visitor feedback.
Part of Great Exhibition of the North 10th July to 10th Sept 2018

https://getnorth2018.com/great-exhibition-of-the-north-success-figures-go-public/

Research Through Design (RTD2019) international design conference, Delft: Tableware and conference paper
The outcomes of a co-created (with Vannucci) workshop involving the use of the tableware was presented as paper entitled: *Enticatypes: Exploring how artefacts can entice conversation on craft values in digital making* (figshare.com) and within the conference exhibition (Right).

2019: **Handmade by Machines**, symposium and exhibition. Birmingham City, School of Jewellery (Right).
https://jewelleryquarter.net/events/handmade-by-machines-seized-by-the-means-of-production/
Accepted through application to present a selection of work at an exhibition of craftworks that used digital technologies in their production. Exhibition held in conjunction with a symposium of that sought to explore and interrogate the relationship between machine and hand production.

2021: Baltic Open*, Gateshead. A set of drawings and accompanying carved piece was accepted through competitive open submission. Group Art exhibition at the internationally renowned Baltic Art Gallery.
https://baltic.art/baltic-open-submission

*This exhibition was due to open in November 2020, but due to COVID its opening was delayed until March 2021.

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REF2021 Research Excellence Framework