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towards a less-GUI interface

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The digitally ‘hand made’ object - the potential impact of new types of computer interfaces on the aesthetics of design artefacts

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ABSTRACT

This article will outline the author’s investigations of types of computer interfaces in practical three-dimensional design practice. The paper contains a description of two main projects in glass and ceramic tableware design, using a Microscribe G2L digitising arm as an interface to record three-dimensional spatial design input.

The article will provide critical reflections on the results of the investigations and will argue that new approaches in digital design

interfaces could have relevance in developing design methods which incorporate more physical ‘human’ expressions in a three-dimensional design practice.

The research builds on concepts indentified in traditional craft practice as foundations for constructing new types of creative practices based on the use of digital technologies, as outlined by McCullough (1996).

General Terms
Performance, Design, Experimentation, Human Factors.

Keywords
HCI, Interface Devices, 3D sketching, Hand Movement, Digital Design Tools, 3D drawings, CAD, 3D Modelling.

1. INTRODUCTION

Throughout the last decades there has been a steady growth in use of Computer Aided Design (CAD) systems in three-dimensional design practice. The range of programs available for this use is now very extensive with long standing applications such as Rhino 3D (2009) and Form Z (2009) having been developed and refined over many years. Equally the range of methods and technologies for prototyping and physical realisation of designs directly from CAD drawing data have also expanded rapidly. A wide range of methods is now available, both in terms of additive, via layer manufacture, and reductive via Computer Numerically Controlled (CNC) cutting.

However, throughout this period of development in the digital design tools there has been little change in basic way most designers interact with these tools. Apart from a few exceptions, the interfaces used in this field have overwhelmingly been based on the Window/Icon/Menus/Pointer (WIMP) and keyboard interface.

Equally there has yet been relatively little development in exploration of the aesthetic possibilities more intuitive interfaces presents to three-dimensional design practice. This paper will ask if more intuitive interfaces could help to facilitate the creation of new types of aesthetics in design artefacts - ones that more clearly reflect the personal expression of designer or the artist behind the creation. This research is focussed on the practical application of new interfaces in 3D design practice and the challenges faced in terms of the production of artefacts which have been designed via these new types of interfaces.

2. Investigating the ShapeHandPlus data-glove as a human computer design interface

This research builds on the finding presented by Jorgensen (2005, 2007), these papers describe research investigating the commercially available ShapeHandPlus data glove from Measurand Inc (2009). This data-glove is explored for its potential as an interface for practical three-dimensional design applications. Although this equipment proved largely unsuccessful in this context (largely due to low accuracy), surface generating methods established in this project provided useful knowledge that was utilized in the investigations with the Microscribe, which constitutes the core of the research described in this paper.

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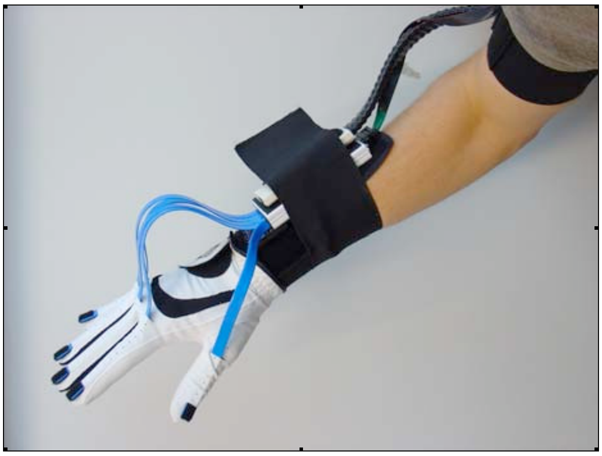

Fig 1. The ShapeHandPlus Motion Capture data glove from Measurand Inc.

2.1 Observations on surface generation

When using a typical motion capture system (such as the ShapeHandPlus system), it is not possible to make direct descriptions of surfaces during the recording stage. Skeletal joint location (and movement data) can only be recorded as a series of Cartesian co-ordinates. A series of these co-ordinates can then be used to generate trajectories of the hand and finger movements and thereby facilitate the creation of three-dimensional splines. To achieve a surface or solid form, planes have to be generated between these splines in a subsequent 3D modelling operation using commands such as ‘lofting’ or ‘skinning’. However, when created, these surfaces have the capacity of clearly displaying the visual evidence of the movements of the designer’s gestural hand movements during the recording, with even the smallest trembling of the hands and fingers contributing to create a very distinctive aesthetic.

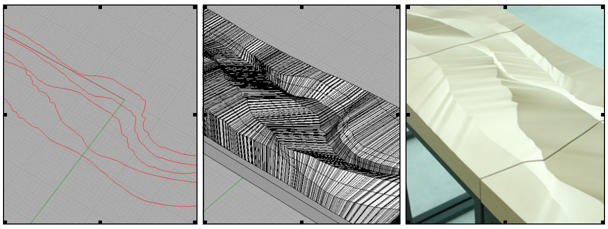

Fig. 2 Surface generation from recordings using the ShapeHandPlus data glove, illustrating the resulting aesthetic reflecting the movement of the designer’s hand and fingers.

3. Using the G2 Digitizing Arm as a human computer design interface

This investigation is related to research by Sener (2003) and Shillito (2004), who both have published papers investigating the use of haptic arms as design interfaces.

The intended application for the G2 Microscribe is not as an interface device rather than as a digitiser for recording co-ordinates of physical objects into CAD programs. The arm has no haptic capability, and there is no standard facility for employing the arm in a virtual reality environment. However the Microscribe dose have several advantages compared to other dedicated interface arms. Due to its intended application as digitiser, it is a very precise piece of equipment, facilitating both dimensional and spatial data sampling with an accuracy of 0.4mm. In contrast haptic arms such as the Phantom from Sensable Technologies (2009) generally suffer from low levels of precision, an issue that has been raised by Sener (2003) as a potential problematic element in the context of industrial design.

Setting up and calibrating the Microscribe is a very quick and straightforward process. The functionality of the scribe is somewhat dependent on which 3D modelling package is used as the equipment connects via plug-ins and is therefore somewhat dependent on the individual program’s capability. A foot pedal connected to the device provide hands-free activation of modelling tools and data sampling, which enables the user to concentrate the use of the hands to interact with the Microscribe. As rotation is limited in some the arm’s axes, the equipment dose not provide the user with full six Degrees of Freedom (DOF). However the Microscribe’s 4/5 DOF is sufficient for the majority of practical design and data sampling tasks.

Fig 3. The G2 Microscribe digitising arm from Immersion Inc.

3.1 Comparing the Microscribe G2 and the ShapeHandPlus as design interfaces

There are some key differences between using the Microscribe and the ShapeHandPlus as design interfaces. Most significantly the Microscribe provides only a single point input, whereas the ShapeHandPlus has the facility of tracking all the human skeletal joints in the arm and the hand. This enables a multiple point input and therefore the opportunity for much more dynamic ‘design expressions’. However, this capability is hampered by the ShapeHandPlus’ very poor dimensional and spatial accuracy. Another problematic element with this equipment is that unlike the Microscribe, the ShapeHandPlus system dose not provide plug-inns for direct input into general CAD programs. Instead the gestural expressions have to be recorded via specific motion capture software, with the raw data having subsequently to be developed into three-dimensional paths to facilitate the creation of designs via CAD programs. This sequence results in a very disjointed creative workflow.

The Microscribe connects to most common 3D CAD packages, consequently the device can be used along side standard modelling commands facilitate by WIMP/keyboard input, thereby potentially enabling the user’s existing 3D modelling skills and knowledge to be utilized. This facility combined with its high level of accuracy means that despite its single point input capability, limitation on reach and restrains on DOF, the Microscribe has to be considered a fairly capable design interface. In contrast the ShapeHandPlus is severely compromised by its poor accuracy and the lack of direct software support within general 3D CAD programs, therefore it cannot currently be considered a usable design interface. However, this position could change if these issues could be resolved, and promising prospects remain for adapting Motion Capture technology to be used as design interfaces to explore new types of aesthetic expressions, as some of the results of the ShapeHandPlus investigation indicate.

3.2 Investigations using the Microscribe G2 to design glass artefacts

This research utilised previously established spatial design drawing methods, using the Microscribe in combination with the Rhino 3D software as describe by Jorgensen (2005, 2007)

Experiments were undertaken to further explore a range of different design input approaches. The various factors explored for their potential impact included:

- Speed of drawing.
- Direction of drawing
- Recording tool selection (curve type and frequency of point sampling).
- Geometric and non-geometric shape interpretations (describing circles, ovals, squares and irregular/organic)
- The use of templates and physical props to guide the drawing and design process.

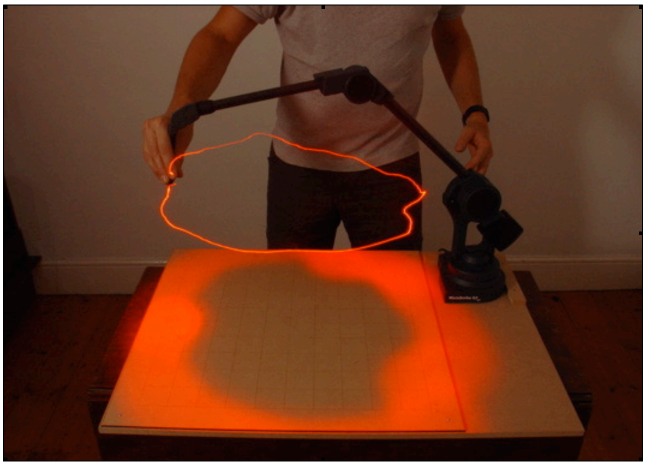

Fig. 4 Drawing/designing with the Microscribe G2

The findings from this investigation indicates a good potential for using the Microscribe to facilitate a much more expressive design input than with a conventional WIMP and keyboard interface.

Included in the aims and objectives of this project was the creation of finished artefacts to enable a more accurate evaluation of the potential for the Microscribe to used as an interface in the context of 'real life' design practice. Glass was chosen as the initial medium for these artefacts. However early investigations using CNC milling to create models to create conventional refractory glass moulds proved relatively unsuccessful, both in terms of the aesthetic qualities and production feasibility. In response an investigation was undertaken to establish an alternative method of producing glass artefacts. This research resulted in the creation of a method which combines a specialist glass forming method called 'free fall slumping', described by Cummings (1997) with a new way of creating refractory moulds specifically developed to facilitate a highly gestural design input.

The mould making process developed (which is illustrated in Fig.5) relies on combining two-dimensional laser cut stainless steel profiles to create a physical model of the three-dimensional spatial input.

Fig. 5 The development of glass moulds from spatial data via laser cut profiles.

Glass bowls manufactured by this process will all feature an edge which is a relatively accurate reflection of the spatial hand drawn design input. This feature is particularly visually evident when the overhanging surplus glass is trimmed away, leaving the optical qualities of the glass to create a dark rim, clearly illustrating the three-dimensional line recorded with the Microscribe.

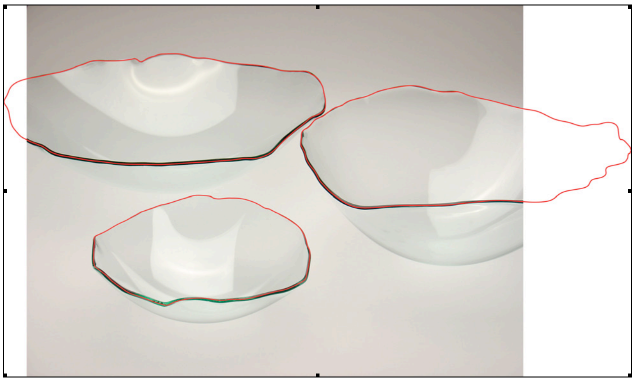

Fig. 6 Examples of glass bowls designed with the Microscribe - the linear design input is superimposed in red on the image.

3.3 Investigating the Microscribe G2 for Ceramic tableware design

In contrast to the glass design investigation this project explored the use of the Microscribe in the context of conventional industrial manufacturing processes, rather than establishing a completely new production method.

This particular context presents challenges in terms of achieving aesthetics which reflects the expressive gestural design input without compromising the manufacturability of the artefacts.

This investigation had the same starting point as the glass design investigation, using the Microscribe to draw spatial 'perimeters' of vessel forms. The project was developed in collaboration with two commercial bone china tableware manufacturers (Topaz China, UK and AsianEra, China). The companies provided feedback on the designs in terms of manufacturability and also in regard to how the distinctive aesthetic of the shapes might impact on the saleability of the artefacts.

Investigations in terms of modelling surfaces from the single line input recorded via the Microscribe, so these forms contained a high level of visual evidence of the gestural movement, was facilitated by critical reflections of the results from the projects with the ShapeHandPlus. Surfaces generated with this equipment were indentified as having a very high level of evidence from the expressive hand movement input. A factor in achieving this evidence was identified in the way the surfaces were created by the trajectories of the individual movement of multiple tracking points (one on the end of each digit). In order to transfer these findings to Microscribe investigation a software modelling method that replicated this approach to surface generation was sought. This was achieved by establishing a simple sequence of modelling commands. This sequence starts by generating a copy of the recorded path, this path is then rotated and moved in the Z-axis to the desired height of the bowl design. From these two paths a slanted and rippled surface can be achieved by using the 'lofting' command. The resulting aesthetic closely resembles those achieved with the ShapeHandPlus equipment with a high degree of visual evidence of gestural design input, as the twisted and rippled surface reflects the direction and movement of the designer's hand when describing the perimeter of the bowl. The data can then used to create physical prototypes and production models via Rapid Prototyping and CNC milling.

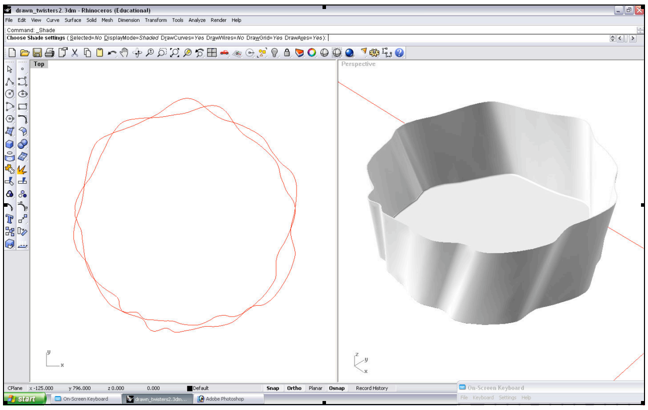

Fig. 7 The Perimeter path copied and twisted to generate a surface aesthetic indicating movement and direction of spatial sketching.

Considerations in terms of manufacturability were also key concerns with this project and this aspect normally impacts with considerable limitations on the use of expressive aesthetics. Using the surface generating method just described, the resulting twisted and ripped shape will inevitably have 'undercuts', which in theory would prevent the use of cost effective single piece production moulds. But using a central datum for the rotation of the copied path enables the shapes to be released from the moulds by twisting (like a screw thread), thereby facilitating the production via single piece mould manufacturing methods, despite the undercuts and expressive aesthetic.

4. Discussion

The investigations with the Microscribe illustrate two different approaches of integrating a new type of interface devise in design and artefact development processes. Unlike other projects (Sener 2003) (Shillito 2004) the core intention of this research is not to investigate new types of interfaces aimed towards improving existing design product development processes, instead the aim is to explore new creative possibilities and aesthetics, which can be facilitated by the use of digital tools and new types of interfaces. The central ambition is to establish systems that can facilitate free intuitive interaction for the designer or artists to create artefacts which in their aesthetics reflect a more 'personal' and 'human' expression. In this approach digital technology is not seen as an 'active tool' rather than a facilitator or conduit for human gesture as the central creative input in the design process.

The projects illustrate two different solutions to the challenge of implementing highly expressive design input via new types of interfaces in practical design and artefact production. The glass bowl design investigation illustrate how production techniques can be adapted and developed to cope with the challenges expressive design input presents, while the bone china tableware design project demonstrate how methods of interpreting a similar expressive design input can be developed and achieved via software tools to fit within existing production capabilities and constrains.

Fig. 8 Examples of the final Bone China tableware designs.

Developments in the fields of Rapid Prototyping and Rapid Manufacturing are likely to provide further opportunities for designing and producing artefacts beyond the constrains of traditional manufacturing techniques. However, despite these developments it is unlikely that these production processes will be able to compete with the majority of conventional industrial manufacturing techniques in terms of speed and costs in higher volume production. Therefore the issue of how to practically adapt expressive designs to be produced with conventional production methods will continue to be an issue when exploring the use of new types of interfaces in the context of three-dimensional design practice.

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