‘Tacitus’ Project: Identifying Multi-Sensory Perceptions in Creative 3D Practice for Development of a Haptic Computing System for Applied Artists.

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Abstract:

This paper outlines the major motivating factors concerning a novel collaborative project between Edinburgh College of Art and Edinburgh Virtual Environment Centre. The “Tacitus” project will investigate the use of multi-modal virtual environments, specifically, the haptic (touch) modality, with regards to the creative processes employed by designers working within the field of applied arts. The salient areas of research are described, and the methods by which information regarding these areas will be obtained are considered. Initial investigations have revealed a strong need to mimic the traditional applied artists’ workspaces, with co-location of visual and haptic cues a priority.

Keywords: haptic, applied artist, skill, tacit knowledge, intuitive

1. Introduction:research imperative and context

What would be the most desirable virtual environment that would stimulate the creative practice of applied artists?

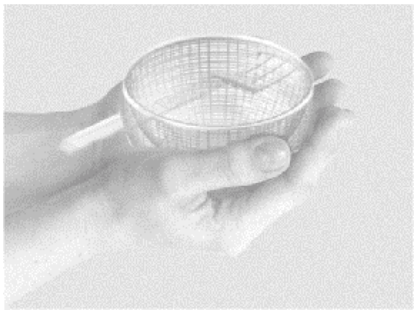

Figure 1: Concept of touching a virtual model.

Current computer interfaces are often alienating impoverished worlds, with little to support the intuitive heuristic working practices of applied artists. If the full potential of new developments are to be realised, it is essential that applied artists are in the vanguard exploring new technology, bringing to it their skills, aesthetics and unique cultural perspectives. “Many of our best art and design students are failing to make the most of the opportunities provided by IT because of their fear or dislike of computers. This not only deprives them of useful skills, but, even more importantly, deprives many IT-based developments of their input.” [i]

The last major survey of the application of computer technology in designer maker practice in 1997, by the Crafts Council of Great Britain, stated that only 40% of makers used a computer and that the nature of this usage varied greatly. When asked what most influenced the decision to buy computers, 32% of this 40% saw the opportunities that computers offered to develop and integrate with the creative aspect of their practice. But

only 13% were using computers as a means of generating and manipulating 3D images. [ii]

The advent of new virtual media and haptic computing means that technology offers not only new tools but also the prospect of entirely new ways of developing work in virtual space. Malcolm McCullough states " what good are computers, except perhaps for mundane documentation, if you cannot even touch your work? The fact that traditional craft endures at all is because it satisfies some deep need for direct experience – and most computers are not yet providing that experience." [iii]

Applied artists' instinctive grasp of constructing and visualising in three-dimensions, their spatial thinking and sense of touch are integral to their process of creativity. Makers combine all their sensory modalities, such as sight, hand motions and gestures, and sound both to explore and bring intended qualities to the object they are making. 'The process is open and evolving: results can only be achieved through ongoing dialogue between the maker, materials and process. [iv]

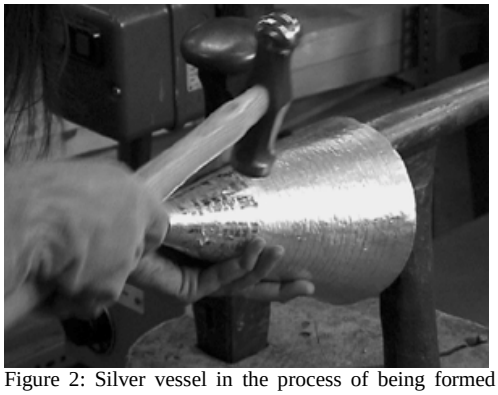

Figure 2: Silver vessel in the process of being formed from flat sheet. Photo: K. Paynter/A. Shillito, 2001

For example in Figure 2, to physically create the vessel illustrated, from a flat sheet of metal, the silversmith needs to understand constraints and have knowledge of the potential of materials, tools and techniques, while having the skill to co-ordinate and control the actions required to achieve creative intent.

In October 2000, with the above indications, Edinburgh College of Art and EdVEC (Edinburgh Virtual Environment Centre, University of Edinburgh) began a three-year collaborative research project, funded by the Arts and Humanities Research Board. The principal aim of their user-centred project is to investigate the development of three-dimensional haptic and multi-sensory computer applications for creative processes in applied arts and design.

EdVEC is a leading centre of excellence for research, development and application of virtual reality and virtual environments in academia, industry and commerce. Their focus is the capture of real world objects, domains, humans and motion, to extract structure to enable navigation, visualisation, measurement and interaction. (See figure 3)

Figure 3: Still of a recent animation of motion captured dance sequences, where virtual dancers were incorporated into a live performance (Soul Survivor by the Dance Theatre of Ireland and the Dublin Institute of Technology. Performed at the Galway Arts Festival in 1999 and then on tour).

User-centred research will involve applied artists at all stages - Edinburgh College of Art has a long tradition in fine craftsmanship and contemporary design and is aptly placed to study multi-sensory perceptions within the arts. We have access to students of varying experience and disciplines as well as experienced practicing staff.

2. Project Overview

As the giving of physical form resides in our hands and creativity itself comes through learning through hands and the sense of touch, these questions arise: -

- How can a digital medium more 'in touch' with creative working practices be

user-friendly and attractive to those disenfranchised and alienated by technology-centred computer interfaces and allow them to bring their awareness of space, mass and form to the virtual environment?

- How can user-centred developments and applications of haptic systems, allied to advances in immersive virtual environment technology and the generation of 3D sound, give designers, makers and artists the potential to use their tacit knowledge, creativity and skills in a wider context?
- How will the development of new virtual tools with haptic and multi-sensory feedback, and the 'invention' of virtual materials with fantastic qualities, enhance the creative process and design practice through the evolution and realisation of innovative concepts?

The main methodologies being used and integrated into a pragmatic and empirical approach are user-centred systems as these emphasise understanding human attributes and need, and involve developing products that satisfy requirements by putting people at the centre of developments rather than technology and equipment.

2.1 Haptic systems and evaluation

'Haptic devices allow users to feel their interfaces and interactions and have the potential to radically change the way we use computers.'[v]

To take advantage of the latest technological advances and to ensure the integrity of the project, Edinburgh College of Art and EdVEC are also therefore collaborating with Reachin Technologies AB in Sweden.

The concept of the "Tacitus" project is the integration of 3D stereo vision, sound and haptics into a computing system, which will have the potential to enable designers and artists to work more intuitively.

Figure 4: Illustration showing the Reachin hardware setup. Copyright Reachin Technologies AB

A haptic system incorporates a device that lets the user touch, feel and manipulate virtual environments. Figure 4 shows the Reachin haptic interface with the user's hands holding two devices. The right holds a finely engineered force feedback mechanism (PHANToM™ - www.sensable.com), the stylus tip accurately calibrated to the x,y,z co-ordinates of the virtual model. When the stylus tip is moved to a point within the working parameters and coincides with any of the co-ordinates of the virtual model, the device exerts a programmable force that is felt directly as a physical restraint. The virtual model can be rotated and moved using the mouse type device in the left hand. The model and tool on the screen is viewed in the semi-reflective mirror that locates it visually in the hands.

In November 2000, EdVEC carried out an investigation for the project, of suitable haptic devices for sculpting and modelling. [vi] From the evaluation criteria it was considered necessary for the equipment to have a reasonable development environment and have reached a commercial stage of development with adequate support. Consideration was given to possible equipment 'extensions' that may be included in later stages of the project such as second modelling feedback devices, tactile gloves or similar devices to simulate handling objects.

The report concluded that artists and designers who would use the equipment had subjective requirements on the method of operation. This required that the virtual object being manipulated and the tools being used to do so, should occupy a position in real space similar to real life and that the mode of working should feel natural and comfortable. Figure 5 (left) shows the traditional working position of a jeweller at a bench. The haptic system to be developed in this project utilizes the concept of co-location to give the user a natural working position and Figure 5 (right) illustrates how this system 'co-locates' the senses of touch and sight in a three-dimensional space.

Figure 5: Comparison between traditional jeweller's working position and co-located haptic/visual display. Copyright Reachin Technologies AB/Photo: A. Shillito/K. Paynter, 2001.

The Reachin™ product, which utilizes the Phantom force feedback device, largely meets the needs of our project as it is the only system that properly integrates touch and vision. The Reachin environment is the first commercial natural multi-sensorial interface in the market for desktop users. Reachin has succeeded in creating an environment conductive to easy and rapid development of multi-sensorial applications.[vii]

2.2 Initial studies

These indicate that central to the development of an intuitive system will be an understanding of tacit knowledge regarding material constraints. In the case of the creative process of applied artists, material constraints provide an affordance to the imagination, rather than a barrier. For example, an artist must understand the potential of materials, tools and techniques, whilst having the skill to control the actions required to achieve creative intent.

This view of constraints is in stark contrast to the traditional notion of virtual reality (VR), which allows us to interrupt the sensory feedback loop with the perceived world, and therefore facilitates the omission of material and physical constraints. While this presents many advantages for data visualisation and manipulation, to the applied artist, it removes an essential catalyst to their creativity. Hence, research will initially seek to identify material properties, tools and processes that are salient to the creative process of the applied artist.

Figure 6: Skilful co-operation of glass artists to produce a complex artefact
Photo: K. Paynter/A. Shillito, 2001

Glass blowing (Figure 6) is a good example of the complex skills and tacit knowledge artists possess with regard to the properties and constraints of a material and tools used to manipulate it. Temperature, viscosity and adhesive properties must all be judged accurately with split second timing for a successful outcome. In transference to a virtual environment, some of these variables may be removed or controlled with benefit to the artistic process. However, post work interviews determined that a constraint such as a gravitational field is fundamental to the tacit knowledge and skills of these artists. Hence this constraint must be embodied to some degree in any virtual environment, if the artist is to transfer their skills and tacit knowledge to the virtual workspace.

3. Methodology

The first series of studies will seek to establish a data resource on fundamental user requirements, in order to begin developing haptic computing for applied artists. These are in progress at Edinburgh College of Art, first studying students and staff working in the departments of Design and Applied Art, followed by studies of selected professionals

working in a variety of disciplines and using a range of materials, tools and skills.

3.1 Initial Questionnaire Results

A sample questionnaire filled in at project presentations to ECA students and to professional applied artists revealed the following points concerning computer and handtool use within the field of applied arts:

- A wide variety of preferred handtools, therefore the need to categorise these tools so that generic properties across the disciplines can be extracted and analysed.
- Of ECA students across all disciplines in applied arts, 46% use computers, software named included AutoCAD, CorelDraw and PhotoShop.
- All students in furniture, but no students in jewellery and metalwork, used computers for designing.
- Of professional applied artists invited and attending a presentation about the project, 84% use computer with 23% specifically for design, although this high percentage could be reflected in the interest of those attending in computer applications.

These preliminary results indicate a relatively low use of computers within the applied arts community, while there was a wide variety of handtools employed. It was also observed that single tools are often used for a number of different purposes (e.g. a welding torch can be used to cut, bend or join material), and are therefore very flexible in the hands of a maker. This suggests that the inherent rigidity of current software tools is perceived as a barrier to the creative process.

3.2 Key Areas

In order to establish a meaningful data resource for development of a haptic computing system, studies will be focused in three key areas:

A. Conceptual Approach: elements that support conceptualisation of ideas and the design process.
Focus of studies:

- Range of pathways into the initial creative process/conceptual phase of design: experimenting, sketching, modelling, testing, searching, playing etc
- Identifying preferred techniques/materials/tools that applied artists choose to use in the early conceptual phase of their work: e.g. drawing implements/modelling materials/ inspirational objects and information.
- Range of skills required to achieve creative intent: e.g. drawing/modelling skills

" Designers are usually interested in the most effective means of communicating and developing their ideas, and that often involves the skill of making, as well as drawing." [viii]

B. Skills/Tools/Materials: Core skills, tools and materials used by applied artists in the creative process.
Focus of studies:

- Preferred tools and materials
- Qualities and effects achieved by makers using preferred tools and materials
- Skills required to achieve these qualities and effects
- Generic material and tool qualities and properties across disciplines

Figure 7: Professor Tony Franks, ceramist
Photo: A. Shillito/K. Paynter, 2001

As an example of the creative exploration of materials, Professor Tony Franks (Figure 7) has added organic material (leaves) to porcelain to imbue the material with specific properties. When the piece is fired, the leaves burn out to give a unique porous effect, the texture and colour of which are enhanced by the finishing process.

C. Computers: Constraints and affordances

within current computer graphic and 3D design applications.

Focus of studies:

- Range of design software used currently
- Intended use of design software
- Assessment of current software capacity to accommodate design process and creativity
- Wishlist for ideal virtual design tools and environment

Interview during the design procedure would be highly disruptive to the artists' thought process, and difficult, due to the vast amount of information that must be conveyed regarding procedures, tools and materials. Therefore, photography and video are currently being employed to obtain a record of artists' working methods in process, as opposed to staged demonstration. Subsequent review of the tapes, and post-work interviews will allow detailed investigation of individual artist's tacit inferences.

Using this methodology of stimulated response, we will be able "to get around the cognitive limitations embedded in the method of 'Thinking Aloud', where the demand for explication interferes with and disturbs the cognitive processes. When reviewing the videotapes together… the tapes serve as a mental trigger of their 'Mind Tape' the participant's memory is triggered in a very special way. He or she recall, in extremely detailed grain, what they did, why, what they expected to happen…It is almost as if a 'Mindtape' of their tacit inferences are being replayed." [ix]

Focussed debate, self-study journals and questionnaires will be employed to encourage ECA staff, students and professional applied artists to articulate the reasons for preferred materials and tools and also to imagine ideal qualities for virtual materials, tools and media that would enhance creative practice.

Two of the researchers based at Edinburgh College of Art, are active applied artists of national and international status and integrate 3D and graphic computer applications in their design process (Figures 8 & 9). Their self-observation during initiation and development of their own work will provide a valuable resource.

Figure 8: Jewellery by Ann Marie Shillito in a mixture of refractory metals and techniques such as laser cutting, anodising for colour and CAD. 1989-98.
Photo AM Shillito

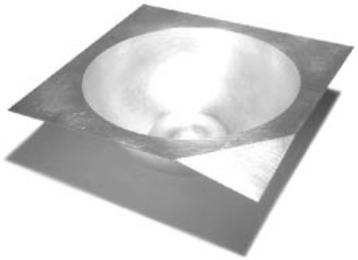

Figure 9: Silver serving bowl by Karin Paynter, designed using 3D computer solid modelling to explore visual effects and resolve design questions, 2000.
Photo: Frank Thurston.

4. Further Studies

Central to the field of applied arts is the notion of "intelligent making"; a mix of formal knowledge, tacit knowledge, physical and mental skill, contextual awareness, innovation, and personal creative autonomy.[x] We will investigate tacit knowledge, haptic and other senses (early research findings indicate the importance of sound to the making process and the continual and equal use of two hands) and look at the relationships between skill and knowledge of materials and tools.

A key element of the research that has been established for further investigation is the link between skill, experience and tacit knowledge. This needs to be identified, and the level at which it needs to be incorporated, in order to develop an efficient multi-modal system. Our intention is to produce a system that is accessible to applied artists, and therefore it is necessary to identify generic tools, materials and techniques, plus the

contribution of other senses such as sound, in order to augment the haptic experience.
To create an intuitive system, we also need to understand the relationship between tacit knowledge and intuition. This is imperative to the user-centred nature of the project, to achieve the stated aims of the project, which are:

- To explore the potential advantages of being able to work, think and respond to physical and visual stimuli, in a virtual, fully three-dimensional, non-gravity context, with particular reference to the education of designers and artists and the development of three-dimensional work.
- To discover the degrees of haptic and other multi-sensory feedback required within digital systems to assist designers and artists to work more intuitively.
- To develop viable software applications and virtual 'hand tools' to enhance the creative practice of applied artists.

"Tacit knowledge refers to a body of knowledge which we have gained through experience – both through the experience of our senses and through the experience of doing work of various kinds. Tacit knowledge differs from propositional knowledge in that it cannot be easily articulated or described in words. Nor can tacit knowledge be described mathematically. This inability to describe the core of a craft becomes more and more acute the closer the craft comes to being an 'art'. The particular 'touch' of a violinist, pianist, draughtsman, surgeon, nurse or vet cannot be described, but it can be demonstrated and, to a degree, be imitated or even learned wholly by someone else."[xi]

Data from these studies will be used in an iterative process to evolve digital systems to assist designers and artists to work more intuitively and support development of virtual hand tools and viable software application to enhance creative practice.

Conclusion:

This paper has outlined the primary research goals of the Tacitus project, which seeks to develop a multi-modal virtual environment capable of meeting the needs of applied artists, craftsmen and designers. In particular, the project will focus on the use of tacit knowledge by artists and designers, and the role of material constraints and properties in the creative process. Our goal is not to imitate the working practices and environment of the craftsman, but to create a generic virtual environment that can be applied to a variety of 3D creative disciplines, in which the applied artist feels comfortable and uninhibited by the novel synthetic environment and yet can bring their experience and knowledge to extend their levels of creativity more fluidly using a new digital medium.

Creative people are more likely to engage with new digital technology when systems enhance and support their practice.

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Biographical Notes:

Ann Marie Shillito is a Research Fellow in the Department of Design and Applied Art at Edinburgh College of Art. She is a designer maker in the fields of jewellery and metalwork and by maintaining an experimental approach, research has become an integral part of her work.

Her current concerns are within the fields of computer-aided design and solid modelling for production methods such as laser cutting and layer manufacture and research is practice based.

She is the project manager and researcher for 'Tacitus', a collaborative project to develop a user centred haptic computing system for applied artists.

Karin Paynter is a research assistant for the 'Tacitus' project, within the department of Design and Applied Art at Edinburgh College of Art. She completed her post-graduate studies at the Royal College of Art in 2000. During this time she explored the application of computer aided design techniques to silversmithing, using 3D modelling to conceptualise and visualise her designs for hand and machine manufacture.

She has worked in industry as a fashion jewellery and accessory designer and has exhibited her own work both nationally and internationally.

Dr Mark Wright is a senior researcher at Edinburgh Virtual Environment Centre (EdVEC) which is part of the University of Edinburgh. In 1994 he received a PhD from the University of Cambridge on how robots can be made to see and grasp objects in the world using symmetry as a visual cue. He conceptualised the National 3D Data Capture Centre at EdVEC, which houses many tools to capture objects, people and places. His arts related research interests include Interactive Narrative, Immersive installations and how technologies such as virtual reality at first mediate and finally transform our perceptions.

Dr. Steven Wall is a Postdoctoral Research Assistant in the Edinburgh Virtual Environment Centre (EdVEC), University of Edinburgh. He obtained a PhD for research in the area of haptic interfaces at the Department of Cybernetics, University of Reading, in December 2000.

His research interests include sensory interaction in multi-modal virtual environments, specifically, in order to overcome limitations inherent in current haptic devices, and promote efficient and intuitive user interaction.

He is also a member of the organisation and programme committee for the International Conference, "EuroHaptics", held in Birmingham, UK, July 1-4th 2001.