The Visualisation and Making of Sculpture and its Potential Implications for Computer Interfaces and Three-dimensional Modelling.

David Prytherch and Robert Jerrard
Birmingham Institute of Art and Design
University of Central England
Corporation Street, Gosta Green,
Birmingham, B4 7DX, UK
artwheel@bigfoot.com
bob.jerrard@uce.ac.uk

Abstract

The deep tacit knowledge of material, tool and creative process, developed over many years of professional practice as a sculptor or applied artist is examined and outlines of an analysis of 'sensory feedback loops' present in a specific making process are described. The significance and role of the sense of touch within the development of 'making' skill is discussed in relation to 'embodiment' (or transparency) in processes involving both real and virtual, tools and materials. Conclusions are related to the human-computer interface and specifically concern the role of haptic and other sensory feedback in the visualisation and creation of three-dimensional virtual objects. A progressive staged model of this is described in relation to the Artist/Craftsperson('maker').

1. Introduction and background

The authors are involved in detailed research surrounding the potential role of haptic feedback in creative making processes. The background and approach of this research arises from the problem of reconciling the needs and aspirations of artists whose work is grounded in the making of material, i.e. non-virtual three-dimensional artworks, with the potential use of computer visualisation systems.

2. Methodology and analysis

Reflection on the author's glass sculptural work and the unique techniques and processes that have been developed over 25 years of professional practice, together with an examination of the visualisation models employed by sculptors, provided the basis of consideration of the qualitative analysis. This paper describes research which centres on an experimental view of the author's and others profound 'making' experience. Issues of intentionality and skill level within each task would also seem to be significant factors.

For the purpose of the analysis, the task can be broken down into three elements, Human, Tool, and Material. The process, chosen by the maker, and influenced by the material and available tools may be said to act as a mediator in the task; all sensory feedback is evaluated within its domain. In this basic scenario, that of unskilled beginner engaged in a non-specific process, both tool and material are 'other', neither are yet embodied. Perception is engaged by all the senses and is directed at both tool and material via process. Thus the task becomes subordinated to conscious and sub-conscious filtering and sensory feedback evaluation. In the case of a non-specific task, any or all of the senses, touch, hearing, vision, taste and smell may be engaged, however the processes themselves define which senses are engaged dependent on the particular task.

In figure 1, which refers specifically to a technique of carving glass, the senses of smell and taste are normally irrelevant. However, touch, sound and vision all convey useful information. (As a novice with any process, all available sensory feedback is monitored). The peculiar characteristics of the process however, place vision in a subordinate role to the other two senses, since due to the refraction and reflection of the water used as cutting lubricant, and the profusion of glass powder produced as a result of the process, little can be seen.

Prior experience of similar processes, materials or tools appears to speed up the development of embodiment and to make the development of skill specifics more rapid. Figure 2, examines the case of a later stage in skill development where a reasonable change in the constituent elements of the feedback loops.

This is an interim development towards full mastery. The tool has achieved embodiment and has become a natural extension of self. The amount of time and

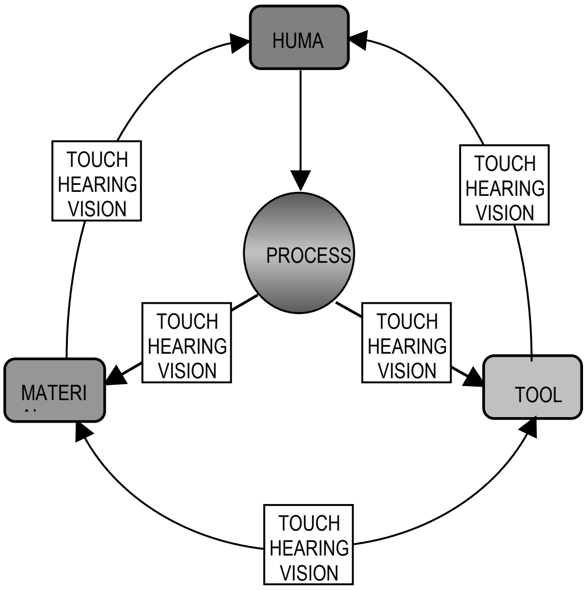

Figure 1. Sensory feedback pathways in glass carving by rotating diamond tool. (Novice).

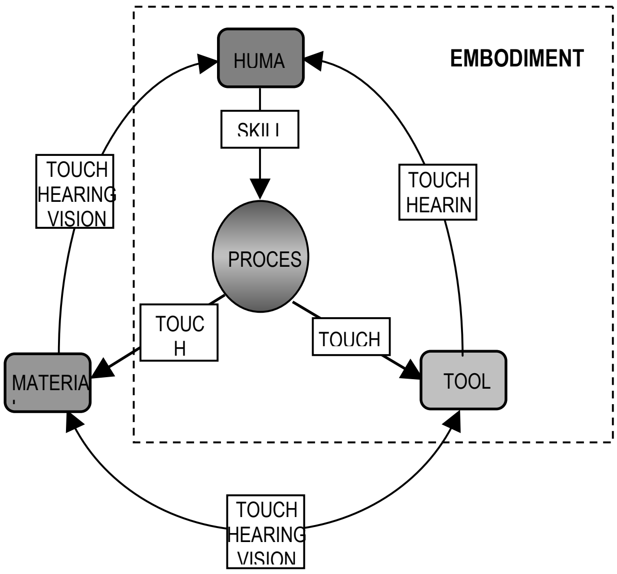

Figure 2. Sensory feedback pathways in glass carving by rotating diamond tool. (Moderate skill).

habituation necessary to achieve this state is variable. Perception in this case appears to be solely directed towards the material. It is significant that the sense of touch has by now become dominant, indeed it is difficult to imagine an embodiment that could take place at all, in the context of making, without a highly developed form of this sense.

As basic skill develops to 'mastery', a state that takes many years to develop, a particularly interesting

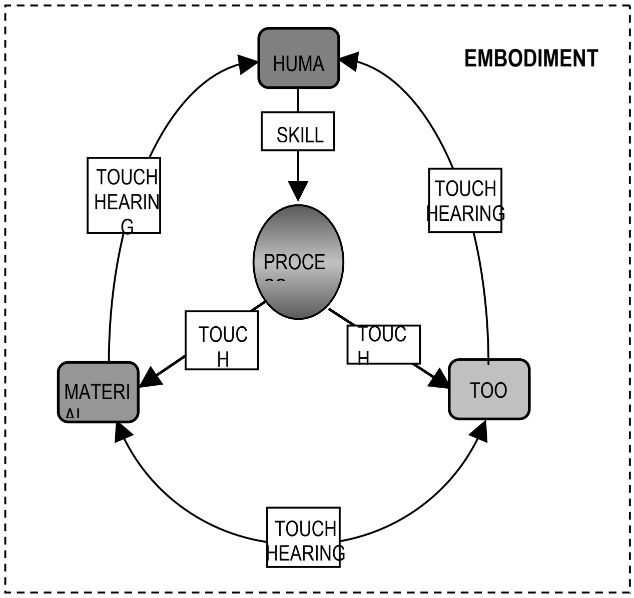

Figure 3. Sensory feedback pathways in glass carving by rotating diamond tool. (Mastery).

phenomenon has been observed. Not only does the tool become embodied as described by Heidegger [1], but also embodiment grows to include the material being worked.

In figure 3, both tool and material have achieved embodiment. The amount of time and habituation necessary to achieve such a state of '*material embodiment'* is considerably longer than the previous case that embodied only the tool. It was seen that touch was integral in all parts of the maker's sensory loops, and is the only means of response to any information, no matter by what sensory input it arrives.

Full embodiment reduces response time to a level of 'transparency'. England [2] defines this as, *" ...a well learned ... motor behaviour which can be performed without conscious attention."* (p.159.) He further states, *"Movements faster than the visual processing time (e.g. 190 ms) may therefore be under kinaesthetic control."* (p.161.) and cites the studies of Carlton, [3] and Glencross, [4] which seem to indicate that kinaesthetic response times may be swifter than visual triggering due to the differing physiological mechanisms involved.

The authors believe that this analysis of skill development indicates that if computer technology is to be applied to processes resulting in material objects,(e.g. sculpture or industrial products), haptic feedback is vital for the development of full embodiment, and that full embodiment is necessary to achieve maximal control and skill 'mastery'.

Performing a similar analysis of the current standard interface devices shows a picture where true embodiment is simply not possible, since tool and material both exist in computer space. This situation is somewhat analogous to attempting to re-arrange the furniture in one's house by standing in the garden poking a stick through the

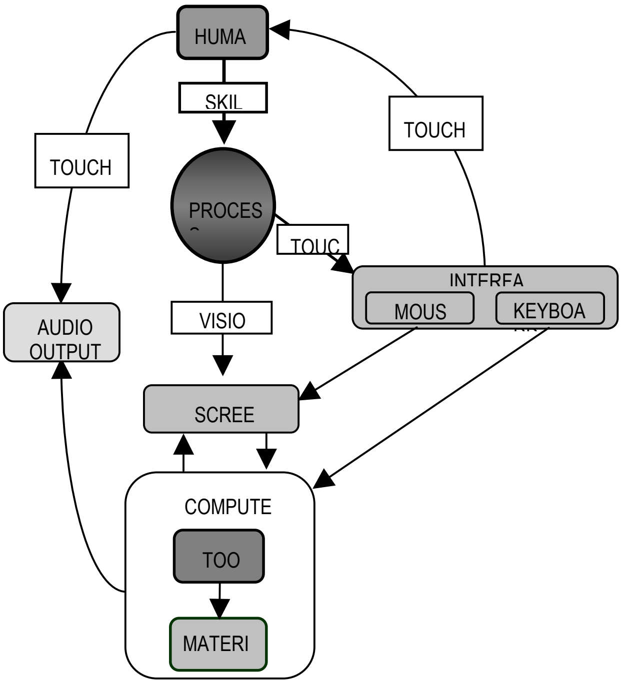

Figure 4. Sensory feedback pathways in current standard human-computer interface.

window.

In figure 4, touch feedback is restricted merely to the physical interface device, mouse or keyboard. No direct contact is available between the user and that which he / she seeks to manipulate. If the material being manipulated is solely abstract information, this might be acceptable, however computers are increasingly being expected to manipulate informational representations of objects, real or imagined, thus providing an alternative interim emphasis. New metaphors must be devised to elicit the ways we personally model computer technology if we are to develop new and more integrated ways of using their potential. Coyne, [5] identifies three basic metaphors implicated at the outset of computer development. The computer as "calculating device", the computer as a "drawing tool" and the computer as "an intelligence". He further identifies a variation on the drawing metaphor as: *"... to see the computer as a modelling tool. Drawing and calculation conspire to construct a powerful metaphor of the design model. A drawing is a two-dimensional model. Cartesian geometry is used to specify values for points, lines, and planes, which are in turn models, or perhaps metaphors of designed objects."*

There is however, a considerable experiential gulf between **drawing** a three dimensional model as Coyne's metaphor suggests and actually **making** one, putting ones hands either directly or via a hand held tool onto a piece of material, and shaping it as one wills. The progressive model outlined in figures 1, 2 and 3, describes the evolutionary nature of material 'knowing'. This experience is somewhat reproducible by computer technology in the domain of two dimensional, drawing or photo-manipulative software. What the computer is currently unable to recreate is an authentic three-dimensional process.

3. Conclusions

Conclusions are based around the implicit hypothesis of positive tacit action in making objects. The novel process of analysis surrounding a personal practice is considered to be a rich source of qualitative information. This has now been extended to include other practitioners across a range of disciplines so that comparisons may be made.

- In process-based 'making' activities with tool and material, embodiment (transparency) develops with skill, first the tool becoming embodied, and much later the material also becoming embodied.
- This process of embodiment is fundamental in skill development and develops directly from the sense of touch. It is not primarily a cognitively learned process.
- Current computer interface technologies do not address this embodiment of tool and material adequately, rather there is substituted an embodiment of the technology itself.
- The perceptual experience of a physical three-dimensional object is markedly different to the perception of an iconic representation of that object and consequently the manipulation of each requires and develops substantially different skills.

References

1. Heidegger, M. (1962). *Being and Time.* San Francisco: Harper Collins.
2. England, R. (1995) Sensory-motor systems in virtual manipulation. In Carr, K. and England, R. (Eds) *Simulated and Virtual Realities : Elements of Perception. London : Taylor & Francis.* pp. 131 - 177
3. Carlton, L.G. (1992) Visual Processing Time and the Control of Movement. In Proteau, L. and Elliot, D. (Eds), *Vision and Motor Control,* Advances in Psychology 85, Stelmach, G.E. and Vroon, P.A., series editors, pp 3 - 31. Amsterdam : North-Holland, Elsevier Science Publishers.
4. Glencross, D.J., (1977) Control of skilled movement, *Psychological Bulletin.* 84, pp 14 - 29.
5. Coyne, R. (1995). Designing Information Technology in the Postmodern Age : From Method to Metaphor. MIT Press.