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MULTIMODALITY – A STIMULANT TO DESIGN CREATIVITY?

Kevin Miller, Gordon Mair

ABSTRACT

Design thinking is a complex process reliant on divergent thought and multisensory, tacit knowledge. Design and creative practice is, therefore, difficult to communicate and to understand. Metaphors play a key role in design, helping designers simultaneously frame problems while exploring possible design solutions and it has been argued that embodied, metaphoric thought even forms the very basis of our conceptual system. The prevalence of inter-sensory (or synaesthetic) metaphors in everyday language, and particularly its prevalence in creative individuals, suggests a link between sensory experience and creative conceptualization. This is reinforced by the apparent existence of different, sensory learning styles that aid communication of knowledge. It is proposed that the use of novel, multimodal metaphors could aid divergent thinking, the communication of creative practice and understanding in engineering design.

Keywords: Creativity, Metaphor, Synaesthesia, Learning, Multimodal Metaphor

1 INTRODUCTION

The 'Designing for the 21st Century' (D21C) initiative – the first venture in design to be jointly funded by the Engineering and Physical Sciences Research Council (EPSRC) and the Arts and Humanities Research Council (AHRC) – was created to stimulate new ways of design thinking, promote cross-disciplinary working in design and foster a new, shared understanding for tackling the design challenges of the future. *Multimodal Design Imaging* is the title of one of the 21 interdisciplinary 'research clusters' established and supported by the initiative from January 2005 to January 2006.

The premise of the cluster was based on the notion that the stimulation of different senses can evoke different images, concepts and emotions that can lead to new insights and change our normal experience of the world. The research explored the cognitive and communicative roles of multimodal representations in design practice and aimed to determine how the phenomena could be used to: aid creativity; enhance communication; and support learning in design.

In keeping with the nature of the initiative, the cluster's members were chosen from a range of disciplines: from sculptors, musicians and psychologists to computer scientists and design engineers. Being comprised of individuals from the arts and the sciences, group discussions and workshops soon highlighted a lack of a common frame of reference and a difficulty in communicating the tacit, experiential and, therefore, inherently sensory knowledge of characteristic of design activity – a difficulty which has frustrated the effective support, understanding and teaching of creative practice and led to technological solutions not always sympathetic to artistic and design thinking and processes.

2 DESIGN THINKING

Design thinking is not only considered to be the primary activity of engineering, but is also complex [1]. The nature of design problems makes particular demands of the designer, with the resolution of conflicts and the solving of problems often being attributed to creativity. This makes design hard to learn and even harder to teach [1]. As we gain a better understanding of genuine creative practice, the traditional perspective on design (normally depicted as a process of: analysis-synthesis-evaluation) is increasingly being questioned and new opportunities for teaching and practice are emerging.

2.1 Problem Setting and Divergence

Asking questions is fundamental to design. The incomplete nature of specifications prompts the designer to inquire and elaborate on requirements, framing the problem with constraints that are essential to a good solution [2]. Schon [3] thought of this as a conversation between designer and design situation and described it as 'reflection-in-action'. Through reflection, the designer's conception of and approach to the problem changes as design progresses – there is a reciprocal relation between problem and solution such that developing either enhances understanding of the other [2].

Thorough exploration and setting of the problem is, therefore, essential as it determines the number and type of constraints introduced, the approach taken and the range of possible solutions. Generative design questions are used by the designer to aid exploration of the problem and are characteristic of divergent thinking [1]. The designer attempts to diverge from facts to the possibilities that can be created from them [1] – thus expanding the conceptual space of the design problem.

2.2 Perceptual Reasoning

Such questioning does not take place independent of the environment. The ubiquity of sketching in design reflects the process of design thinking described above while also betraying the need for externalization and interaction. Studies of sketching in design show how their vagueness and ambiguity affords a range of interpretations by the designer, leading to unintended consequences and unexpected discoveries, that can be tested and developed [3], [4]. Chandrasekaran [5] describes the activity as a process of perceptual reasoning and it is a process similarly observed in the arts and crafts.

Concepts are not born separate to any technical mediation, but are formed as artists work with materials and develop their craft. A sculptor's capacity for conceiving and understanding in three dimensions will have been developed through both the sense of touch and vision [6]. Different patterns of touch provide different meanings and this combination of visual and tactile information is pivotal to their creative process. Use of visuospatial reasoning is also evident in engineering design during, for example, the construction of prototypes, with fidelity often being traded for usefulness of inquiry [2].

In the arts and crafts, this skilled, creative practice is known as 'intelligent making' and, it is a perceptual reasoning process, reliant on a multisensory, tacit understanding that is difficult to articulate and, therefore, to teach and for others to understand.

2.3 Interaction

Interaction with the environment and materials gives cognition richer and more relevant feedback [2]. Lack of interaction can lead to naïve conceptions of the design situation, inaccuracy and unnecessary obstacles. This is why the Aristotelian notion of heavier objects falling faster than light ones was never disconfirmed by thought experiments

[2]. Indeed, various studies have shown our abstract conception of the world to be distinctly pre-Newtonian [7]. Figure 1 was shown to high school students in a study by White and Howitz [7]. When asked which path would be followed by the ball when the runner drops it (the correct path being A) the students' application of naïve theories of motion resulted in only 20% of the subjects getting it right.

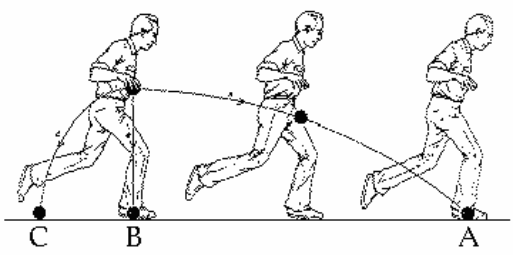

Figure 1. White and Horwitz's student thought experiment (from [7])

Similarly, in a study by Linder [1], engineering students performed poorly when asked to estimate physical quantities within 5 minutes (such as the drag force on a bicycle and rider at a given speed). Such results indicate a lack of active manipulation and engagement with the world and an inability to form appropriate analogies to conceptualize problems – two areas that may not be unrelated.

At a time when our experience of the world is increasingly being mediated by different representations, such as CAD, it is appropriate to ask: how we can re-introduce a sensory, tacit understanding that could enhance the learning of engineering concepts while broadening the creative scope of design solutions? What will be the new skill and knowledge base of the future, and how can this be exploited to aid design? What new skill bases do we want to develop for the future? If intermediary representations must be used in learning, how could they be made more effective? Could better analogies and metaphors be designed to aid conceptualization in engineering design?

3 METAPHORS

Metaphors are used to help us understand one thing in terms of another and make the unfamiliar familiar. Through this, metaphors also play a key role in the way we structure and approach design problems and can be considered as cognitive strategies in design [8], [9]. With respect to the preceding discussion on design thinking, metaphors are considered an essential element of divergent thinking in design – Schon referred to them in such situations as 'generative metaphors' [3]. It should be noted, however, that while metaphors are a powerful aid to divergent inquiry, they must be used effectively as they can also restrict thought (and, therefore, design) by the very fact that a particular metaphor has been chosen [9] (consider the questionable view of human cognition as 'information processing'). Three applications of metaphor to aid exploration in design have been observed [8]: the switching of metaphors; the extension of existing metaphors; and the use of novel metaphors.

Such applications can provide a wider perspective on a design problem, with new associations being made to afford a greater scope for exploration. The process of metaphorical reasoning has already been investigated in design [9] and their potential for use in design education has also been studied [10].

3.1 Embodied Metaphors

In their influential analysis of metaphor, Lakoff and Johnson [11] argue that many of our most basic concepts (and reasoning via those) are embodied – lived experiences that inspire and constrain the way we perceive and communicate other experiences. The language we develop and use is not, therefore, only embodied, but it is inextricably linked to the way we behave, reason about and interpret the world.

Interestingly, many metaphors used in everyday language are sensory blends (or synaesthetic) [12]. Examples of the phenomenon include: 'bitter cold', 'sharp cheese', 'loud shirt' and 'hot saxophone'. These 'synaesthetic metaphors' also exhibit the directionality observed in genuine synaesthesia [12] (e.g. from the auditory to the visual modality) and it is proposed that, if they are understood and applied effectively, could provide a means of introducing a sensory logic at a semantic level, allowing for a novel means of understanding, communicating and stimulating creative practice.

4 SYNAESTHESIA

Synaesthesia is a condition in which a person experiences sensations in one modality when a second modality is stimulated [12]. Instead of simply using metaphorical language (such as in the examples above), the properties of sensory experiences (or qualia) of these individuals is genuinely 'blended'. Studies further indicate that there is higher incidence of the condition in creative individuals such as artists, poets and musicians. It has even been suggested that a better understanding of synaesthesia could provide a neurological insight to creativity [13].

4.1 Synaesthesia and Metaphor

Creative individuals appear to share a disposition towards the generation and application of metaphor [13]. An apparent link between synaesthesia and metaphor is, of course, the linking or association of seemingly unconnected domains – with synaesthesia inducing links between perceptual entities and metaphor conceptual realms (although synaesthesia may also have influence on conceptual thought [12]).

That the phenomenon (of synaesthesia and metaphor) is more prevalent or stronger in artists does not preclude the ability for making, or understanding, metaphors in the rest of the population. Indeed, as Lakoff and Johnson noted [11], the basis of thought may be embodied and metaphoric and the very existence of synaesthetic metaphors in everyday language alludes to more complex interactions between the senses.

4.2 Visual Metaphors and Synaesthesia

When, for example, people are shown the images in Figure 2 and asked "Which of these is a 'bouba' and which a 'kiki'?", 98% of those asked will assign the title of 'bouba' to the jelly shape 'kiki' to the other figure [13].

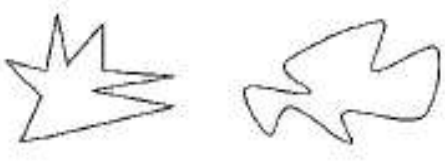

Figure 2. 'kiki', 'bouba' stimuli (from [12])

Ramachandran and Hubbard [13] suggest that this association is perhaps made because the curves of the jelly shape metaphorically imitate the undulations of the sound

'bouba'. They also propose [12], complementing the work of Lakoff and Johnson [11], that the sharp changes in visual direction of the jagged figure mimics the sharp inflection of the tongue on the palate when articulating the word – suggesting that such associations place natural constraints on the way sounds are mapped onto objects and may be a basis for the understanding of proto-language.
An artist or designer's creative process, and the interaction with the materials peculiar to and necessary for development of skill in their discipline, gives them a range of multisensory experiences from which to make associations (consider the sculptor's capacity of visuospatial reasoning). Despite being tacitly understood, new insights to the nature of sensory experience (such as synaesthesia) may provide novel means for communicating their practice to others.

5 MULTIMODAL LEARNING

It has been proposed that the use of multiple sensory channels can lead to more effective learning and a need for consideration of different learning styles [14]. Recent investigations have even defined learning styles in sensory terms (such as auditory or visual learners, tactual/kinaesthetic) [14]. This suggests that the use of multiple, multimodal representations may allow for development of more effective forms of communication. These multimodal forms could help us achieve effects, express intentions and conceptualize in new ways – aiding inquiry in design and the understanding of concepts.

5.1 Multimodal Metaphor

While certain sensory channels are more effective at communicating certain types of information, they can also be used in novel ways. Sound is, for example, best used to communicate time, yet it can also be used to communicate change in quantity (consider the Geiger counter). Stokes [15] relates the story of Toscanini using, physically, the 'graceful descent' of an handkerchief to articulate to the orchestra his concept of Debussy's *La Mer*. Also, while visual representations, in the form of stave notation, are already used to represent music, a recent study observed increased creativity in composition through the use of visual metaphors [16]. Finally, it has been noted [17] that, in *De Architectura,* Vitruvius's principles for architectural beauty makes use of the Greek theory of music (*eurythmia*, for example means 'beautiful rhythm').
Curiously, with respect to the discussion of the 'kiki', 'bouba' experiment, according to research by Nagai and Noguchi [18], design thinking is considered to be a process of expressing a verbally provided objective as a visuospatial image. The researchers propose that the designer searches for metaphors relating to the expression and seeks links between it and shapes generated [18].

6 CONCLUSION

As metaphors and sensory interaction play an important role in design thinking, and as learning may be enhanced through the use of different sensory channels, could the two be combined to create multimodal metaphors for use in design education – metaphors that could help us communicate more effectively while stimulating novel and creative thinking in design?
By asking the recipient to participate in the decoding of more elaborate messages, metaphor gives them a more active role in the communication process and creates a more vivid and engaging form of communication [19]. They also afford potential for

articulation of sensory experiences that could not, otherwise, be understood by others – such as the creative practice of an artist or designer.
It is proposed that the study, development and application of appropriate multimodal (or synaesthetic) metaphors, and principles for perceptual representation, has the potential to greatly enhance the teaching of engineering design and creative practice.

REFERENCES

[1] Dym C. et al., Engineering design thinking, teaching and learning. *Journal of Engineering Education,* Vol. 94, 2005, pp.103-120.
[2] Gedenryd H., *How Designers Work,* Lund University, Sweden, 1998.
[3] Schon D., *The Reflective Practitioner,* MIT Press, Cambridge, 1983.
[4] Suwa M. et al., Unexpected Discoveries and S-invention of Design Requirements: Important Vehicles for a Design Process, *Design Studies,* Vol. 21, (2000).
[5] Chandrasekarn B., Multimodal Perceptual Representations and Design Problem Solving, In M. Petre et al., *Visual and Spatial Reasoning in Design*, MIT, 1999
[6] Shilito A. et al., Tacitus Project, *Digital Creativity Journal*, 12, 2001, pp.195-203.
[7] Svanaes D. Kinaesthetic Thinking: The Tacit Dimension of Interaction Design, *Computers in Human Behavior,* Vol. 13, 1997, pp.443-463.
[8] Hey J., *Metaphors We Design By*, Creativity Assessment Report, University of California, Berkeley, 2004.
[9] Coyne R. and Snodgrass A., Problem Setting Within Prevalent Metaphors of Design, *Design Issues*, Vol. 11, Issue 2, 1995, pp.31-61.
[10] Casakin H., Metaphors in the Design Studio: Implications for Education, *Proceedings of E&PDE '04,* Delft, 2004.
[11] Lakoff G. and Johnson M. *Metaphors We Live By*, Chicago University Press, Chicago, 1980.
[12] Ramachandran V. and Hubbard E., Synaesthesia – A Window into Perception, Thought and Language. *Journal of Consciousness Studies*, 8, 2001, pp.3-34.
[13] Ramachandran, V. and Hubbard E., Hearing Colours, Tasting Shapes, *Scientific American Mind*, Vol. 16, 2004, pp.17-23.
[14] Sankey M. Visual and Multiple Representation in Learning: An Issue of Literacy, *Create. Ed*, 2003, RMIT University, Melbourne.
[15] Stokes S., Visual Literacy in Teaching and Learning, *Electronic Journal for the Integration of Technology in Education*, Vol.1, 2002 [Online: http://ejite.isu.edu/Volume1No1/Stokes.html (accessed 27th March 2006)].
[16] Truman S. et al., A Creative Alternative to Music Notation, *Proceedins of 4th International Conference on Musical Understanding*, Exeter, 2005.
[17] Pont, G., The Education of the Classical Architect from Plato to Vitruvius, *Nexus Network Journal*, Vol.1, 2005 [http://www.nexusjournal.com/Pont-v7nl.html].
[18] Nagai Y. et al., Representations of Design Thinking, *Journal of the Asian Design International Conference*, Vol.1, 2003, pp.1-9.
[19] Satterfield D. Teaching Kansei: Visual, Verbal and Sensory Communication, *Journal of the Design Conference*, Vol.1, 2003.

Kevin Miller
Department of Design, Manufacture and Engineering Management
University of Strathclyde
Glasgow G1 1XJ
Email: kevin.z.miller@strath.ac.uk Tel: (+44) 0141 548 2897