

RECENT DESIGN SCIENCE RESEARCH: CONSTRUCTIVE MEMORY IN DESIGN THINKING

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INTRODUCTION

In 1896 Dewey (1896) published a seminal work on human memory which languished after a while and was only rediscovered relatively recently. In that work he introduced the concept which today is called “constructive memory”. This concept is best exemplified by a quote from Dewey:

“Sequences of acts are composed such that subsequent experiences categorize and hence give meaning to what was experienced before”
(Dewey 1896).

The implication of this is that memory is not laid down and fixed at the time of the original sensate experience but is somehow a function of what comes later as well. It may be viewed as follows. Sensate experience is stored as an experience. Memories are constructed initially from that experience in response to demands for a memory of that experience but the construction of the memory includes the situation pertaining at the time of the demand for the memory. The effect of this is that the memory is not just a function of the original experience it is also a function of what has happened since the original experience and of the situation which prevails when the demand for the memory is made. Each memory, after it has been constructed, is added to the experience so that the experience is augmented by memories of it. These memories require processing of the experience as opposed to factual recall of aspects of the experience. These latter we will call “fact memories” rather than just “memories”. New memories of the experience are a function of both the original experience and previous memories of it. New memories can be viewed as new interpretations of the augmented experience.

Figure 1 shows graphically this conception where memories are constructed from experience and earlier memories which in turn become part of the situation which affects the kinds of memories which can be constructed.

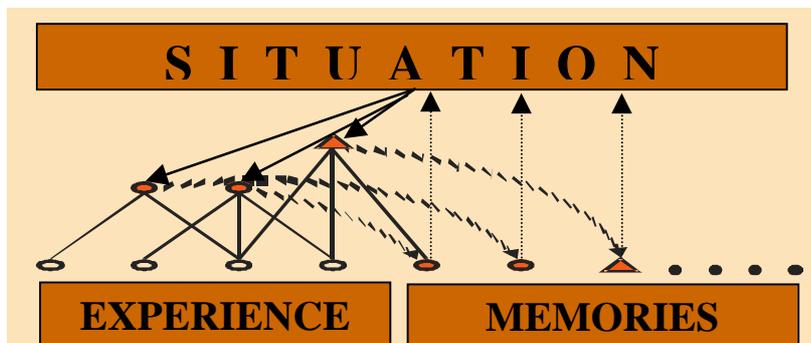


Figure 1: The original experiences, \odot , and the situation are used to construct memories of the experience, \bullet , then these memories are added as experiences and may be used later to produce further new memories, \blacktriangle , in conjunction with later situations and so on.

DESIGN THINKING AND CONSTRUCTIVE MEMORY

What are the implications for design thinking of this cognitive view of memory? Schon's notion of "reflection" (Schon 1983) very clearly maps onto these ideas which provide a cognitive basis for this fundamental aspect of design activities. The ability to reinterpret what has already been drawn and already has a given meaning appears to be one of the distinguishing features of designing (as opposed to problem solving). There is increasing evidential support for this process of reflection or reinterpretation (Suwa et al 1998).

The constructive memory view of designing brings with it the notion of situatedness (ie where you are when you what you do matters). These two concepts allow for the development of models of design thinking which are in closer accord with both our intuitive understanding of designing and with the experimental results currently being produced by analysing design activities.

There is increasing evidentiary support for these views. One area of design research based on cognitive studies of designers designing that is beginning to be examined is the use of sketches in designing. Protocol analysis is the primary tool to examine such cognitive processes in designing (Eckersley 1988; Goldschmidt 1991; Schon and Wiggins 1992; Suwa and Tversky 1996; Suwa, Gero and Purcell 1998). Schon and Wiggins (1992) found that designers use their sketches as more than just external memory, they used them as a basis for reinterpretation of what had been drawn: this maps on to emergence and theirs and other studies provide strong evidence for this form of situated designing. Suwa, et al (1998) have found that designers when sketching revisit their sketches after a while they sometimes make unexpected discoveries, Figure 2. Further, these unexpected discoveries do not occur at the time of sketching but later when those sketches are revisited.

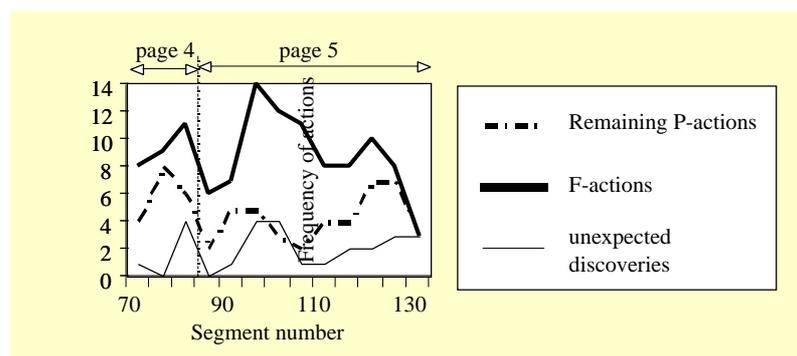


Figure 2. Correlation between unexpected discoveries and functional cognitive actions (F-actions) as opposed to purely perceptual actions (P-actions) in a design session. It can be seen that there is a time shift between the actions of drawing and those of the unexpected discoveries. Segment number refers to the segments in the protocol and the page number refers to the pages of sketching (Suwa, Purcell and Gero 1998).

They concluded that “sketches serve as a physical setting in which design thoughts are constructed on the fly in a situated way”.

Emergence may be seen as one example of situated constructive memory in that it can be viewed as new interpretations of the experience. This conception fits well with Gombrich’s view of emergence as seen in the works of artists.

“In searching for a new solution Leonardo (da Vinci) projected new meanings into the forms he saw in his old discarded sketches” (Gombrich 1966).

Figure 3 shows graphically the notion of how a situation affects what can be “seen”. In Figure 3(a) where two black human-like heads in profile are drawn, a white vase can be seen to emerge. Here, the two human-like heads provide the situation within which the emergence occurs. However, when only one black human-like head in profile is drawn no vase emerges. Here, the single human-like head provides the situation. Clearly, in this example, the situation controls the emergence.

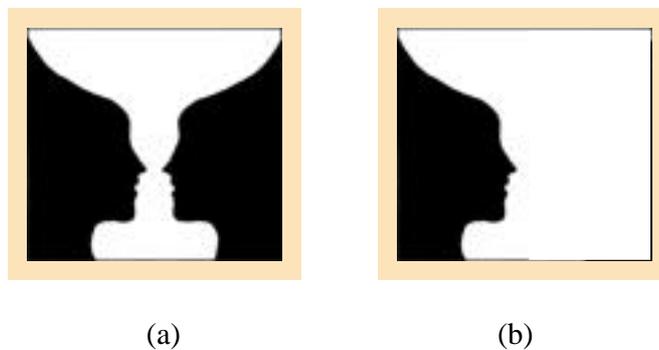


Figure 3. (a) Two black human-like heads in profile, reflections of each other create the Fig. 2. situation where a white vase can be seen to emerge; (b) a single black human-like head on the same background does not create the same situation and therefore no emergent vase can be found.

Situated emergence, it is claimed, plays an important role in designing and can be modelled to produce novel results when the results of an emergence process are used to change what can be designed (Gero and Kazakov 1998)

DISCUSSION

These ideas form the basis of a research program which aims initially at developing formal representations of situatedness and constructive memory in designing (Gero 1998). The significance of the confluence of these two ideas lies in our ability to use them to explain aspects of the acts of designing which previously eluded formal explanation. As we discover more about designing it becomes no less a special act, just as discovering more about the stars makes them no less special. However, whilst knowledge about the stars may enrich us intellectually, knowledge about designing provides the opportunity to change and improve it and consequentially to change the designed environments we inhabit.

The results of such research provide the basis for the development of richer formal models of designing. These models in turn can be the basis of computational models

which allow the direct testing of these ideas. Without these richer models, without their computational implementation and without their testing new design support tools cannot be adequately developed.

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