Divergent thinking and the design process

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Abstract
The paper explores a view of research on creativity in design not based on traditional cognitive science models. Research from the creative cognition standpoint is reviewed with an example and the problem of applying it to the design case is explained. Creative techniques used in design lack a scientific base and lack an evaluation of their effectiveness. They emphasise the generation of ideas and not the generation of tangible solutions. The argument states that design research should be looking neither to the act of idea generation nor to the act of form generation and reinterpretation but to the enacted use environment in which designers operate and from which functions emerge. Departing from new models in cognitive science two hypotheses are formed. The first claims that the creative outcome in design may be based on an enacted experience of use and not on a rationalisation of imagery or represented forms. The second claims that diagrams created during the design process, mainly in its first stages, may serve the purpose of problem finding and not of problem solving.

Keywords: creativity, cognition, imagery, sketching and design

1. Introduction

It is not the objective of this paper to invalidate any definition of creativity, but only to investigate it within the design case, identifying the general lack of emphasis given to the role of concrete representations that are used while creating. In fact, in most cognitive psychology research about creativity, the moment of divergent thinking seems to be achieved only by using mental concepts or imagery and never external perceivable images. On the other hand, in the research on design thinking, many of the conclusions from design protocols are misleading because they attempt to follow the traditional models of cognitive psychology, which often fail to attend to the particular nature of design (Winograd and Flores 1986; Lakoff and Johnson 1999). As a result, design research finds itself dealing with contradictions[1] that may have to do with fundamental misconceptions regarding cognition.

The first part of the paper presents the main points in psychological research on creativity as well as the consequent models produced.

[1] Namely the one that contradicts the generally accepted view that form follows function. Purcell and Gero (1998) claim that function follows form based both on cognitive psychology experiments and design protocols.

The second part is a characterisation of creativity enhancement techniques largely adopted by the design community. In the third part, based on research about the design process, some accepted justifications for the use of external representations in design are presented. This establishes a ground on which to build, throughout the paper, an argument of the inadequacy of current commonly accepted creativity theories and methods with regard to the design practice.

The conclusion presents possible research hypotheses to the problem of creativity in design as a way of showing future research paths that may develop more useful integrated approaches for the design profession.

2. Creativity in the mind

Creativity is generally accepted in cognitive psychology as the capacity to perform mental work that leads to an outcome both novel and applicable. This definition is extensively used throughout the literature that is directly related with the subject (Mayer 1999). The novelty dimension was present since the beginning, when creativity was still seen as a mystical phenomenon; it remains the key concept to explain it. Mednick (1962) is the

first to distinguish creative thinking from original thinking in the way that the former had to produce useful outcomes while the latter only had to produce novelties.

Research on creativity is usually done with regard to a mental process, a personal characteristic or an outcome episode (Mayer 1999). It is seen as a capacity that can be important to achieving a better or worse condition in human daily activities. In this sense, creativity is studied in the same way intelligence is and, like intelligence, those who are more creative are seen as better mentally equipped to cope with the everyday problems presented by the environment. So, cognitive psychology is interested in understanding the creative individual as a mental entity that can be assessed through concepts or imagery manipulated in the mind.

Moreover, most of the research in cognitive psychology is done by building experiments where the subjects are asked to deal with words and abstract concepts and the outcome is usually a fusion of concepts that has no real representation.

In some experiments visual elements are used. However, the level of abstraction remains too high to be considered in design. In a typical experiment (Finke, 1996), the subjects were asked to combine a limited number of shapes to come up with innovative solutions in a specific domain of objects (e.g. furniture). No context was set and no needs identified. The outcomes were then evaluated by a jury through the presentation of the formal arrangement accompanied by a verbal explanation. The evaluation had two parameters; originality and practicality and the outcomes "were classified as *creative inventions*" (Finke, 1996:383).

This experiment was established on the basis of the model of generation and exploration (Geneplore model) (Finke et al. 1992). In this model, the creative mind generates *preinventive forms* that are subsequently explored. Here, the act of achieving novelty is in the generation phase while the act that gives applicability is in the exploration phase. In this frame, subjects are asked to generate forms and later give them meaning as a way of exploring applicability. The independence of the moments of generated divergence and verbalised convergence is what is considered to bring creative outcomes.

There are problems in applying this model and these findings to research in design. First, this experimental construction has little to do with a design situation in which the subject is faced with a *wicked* problem (see, for example, Buchanan[2] 1992) where an infinite number of shapes can be produced. Furthermore, in design it is the moment of facing the problem from a particular perspective that lends originality to the outcome. The solution is not generated in a vacuum but in a constrained reality; with what is possible given the constraints of a particular moment.

Second, the establishment of a domain of allowed outcomes brings some reality to the task but does not provide a plausible goal in which to design (Smith and Browne 1993). The domain *furniture* helps the subject focus on a possible set of outcomes, but does not give any clue about the constraints one is likely to face in a real design situation. So, the problem of representation remains abstract; it is one of combining the shapes supplied by the researcher within an archetypal meaning (furniture) and not one of fulfilling, for example, the need for seating.

Third, after one form combination is achieved the subject builds the meaning around it to justify why it fits the domain attempted. It is not to create the right artefact from felt need; it is just constructing meaning through the combination of forms. It is accidental and ungrounded form building where everything may be imagined afterwards, the solution, the constraints, the use, the manufacturing process but nothing is tested in a real situation and the usefulness remains unproven.

Through this model, creativity may be seen as a good way to identify different ideas but not to create innovative solutions that can be implemented. Solution in design is gradually

[2]The first author to think about the wicked nature of design problems was Horst W. J. Rittel, cited by Buchanan in this paper.

built around the experience of making and using and not around a pure formal concept standing on its own. This type of experiment might help to develop an understanding of cognitive structures relating to the conceptual creative process, but because they are established with a totally artificial set of assumptions, they presuppose a different kind of creative task, not the one of design.

The design problem is, in every aspect, different from this one. The designer is faced with a problem based on real constraints that he/she ought to identify during the process, usually starting with ill-defined goals but real needs to fulfil (Smith and Browne 1993). The designer takes on the problem as a situation of use and puts him/herself in the situation of the needed user, enacting (Purcell and Gero 1998) the use and the manufacture with the help of sketches and representations to apprehend the wholeness of the experience. The representation may be produced to enhance a whole mind-simulated experience, to join imagery together in the mind. However, here, we do not see imagery only as a precursor of its two-dimensional representation, but also as an internal multidimensional and multisensory result of that same representation. In this sense we can say that representations in design may have a role, not only as a working memory aid (Simon 1981), but also as experience understanding, and synthesis.

It is difficult to accept that what primarily emerges in creative design outcomes are forms, and that, from those, function follows as its interpretation (or reinterpretation) (Purcell and Gero 1998). In fact, it makes more sense to think about the act of sketching as an externalisation that resonates with the internal formation of imagery in order to help construct and interpret experiences of use. In this sense we can never say that function follows form since it is the inner built experience of use that remains central in the design process, being both form producer and consumer. We urgently need empirical data to support this claim.

3. Creativity at practice

Most popular approaches to creativity are concerned with the possibility of turning individuals into more creative professionals in their daily work. Some of the authors who popularised creativity are De Bono (1971, 1985, and 1992) with his practice of *lateral thinking*, Osborn (1953) with *brainstorming,* and Gordon (1953) with *synectics* among others (Adams 1986, Von Oech 1983, Shaw 1991). Common to all of them is the use of mental strategies to either actively encourage divergence or at least discourage inhibition.

A reason for the easy acceptance of these techniques by designers might have to do with the fact that professionals are, in general, more open to pragmatic approaches to increasing performance and not very concerned whether these techniques have any fundamental scientific basis for their construction. To a designer, the promise of a novel outcome is sufficient to justify its use, but no later assessment of the results is attempted. Jones (1974: 54) points out the absence of evaluation of use of creative methods in design. Nagasundaram and Bostrom (1994: 51) consider that some groups may naturally outperform these techniques when using the right communication tools. The lack of further evaluation of creative methods in design practice is an evident fault.

However, a bigger mistake precedes this. The scientific psychological basis for these methods is yet to be found and, even if they were established in an academic context, they usually try to look like applied theory without previous scientific understanding of the cognitive phenomenon of creativity (Sternberg and Lubart 1999).

Besides the absence of scientific validity, one aspect in the indiscriminate use of these methods in design is revealing. Most of them were conceived based on a purely mental process, a play with words and concepts previous to the evolution of physical representations. Such "idea generation" techniques might be useful to certain activities

where the deliverable is a report, but in design the creative process does not end with a concept; the designer is searching for a concrete form, for a representation of a future reality. That design creation does not end in a concept is an unarguable truth because it obviously ends with a tangible representation of an artefact as close as possible to the final artefact itself.

4. Creativity in design

Most of the research done on aspects of creativity in design is related to the use of representations during the design process. It is now well accepted that representations follow a path of progressive elaboration through the design process from an ambiguous, unstructured and abstract nature towards a structured and more concrete represented reality. It is also accepted that the early less concrete and denser representations, such as sketches, are related to the more creative phases of the process. This is explained through a symbol system, fast reinterpretation of meanings and emergence of new and unexpected forms (Goel 1995). However, the reason for the insubstantiality of the sketch may not be found in what this ambiguity serves but in what causes it; it may be a result of the subjective, multidimensional, multisensory and ill-defined nature of the design problem. The designer might work more in a perceptual sphere and less in a conceptual one because his/her aim is a perceivable, felt, manageable artefact.

But, related to this, other issues regarding the nature of reinterpretation and the nature of what emerges in design creation are yet to be found. It may be that the moments of verbalisation both asked by many design protocols and in the previously described experimental procedure (Finke 1996), are only the result of a subsequent rationalisation of what is being sketched to reinforce its acceptance (or rejection). It may be just a result of the culturally created need to rationalise everything that is created, while the true act of creation previously happened during the moments of direct simulated experience in the dialogue between mental imagery and sketch.

We are starting to accept the emergence of forms from enacted reality (Purcell and Gero 1998) previously created in imagery. But the need to search for a better explanation of the role of meaning in design creation remains. There is conceptual meaning and perceptual meaning in the same way as we accept conceptual knowledge and perceptual knowledge (Purcell and Gero 1998). Conceptual meaning is a metaphorical construction based on experience while perceptual meaning is a direct reproduction of the experience in the mind. With the first we can deduct, generalise and build coded knowledge, with the second we can directly feel if something works or not (Lakoff and Johnson 1999). Artefacts may exist without conceptual meaning but it is impossible to create them without any perceptual meaning. Furthermore, this notion of perceptual meaning helps to establish the design process as heuristic with the notion of reflection in practice (Schön 1983) because it is a thinking feature that allows speed and practicality in action. However, both conceptual and perceptual meaning seem to have a utility in the creative act of design, but their specific roles have yet to be defined.

5. Conclusion

First, Damásio (1994) establishes the role of emotions in the process of decision making as our neurochemical link to the environment, so we know that the link exists and that we need it to live. He says that we may have all our reasoning and sensorial processes fully working, but if we fail to emotionally react, that is to say in the design case, to put ourselves in the "skin" of the user, we will not be able to make decisions. In this sense, the creative act in design might just be an immersion into the situation of use, a truly felt empathy, not because we voluntarily acknowledge the user but because we need that connection in order to create. Second, Lakoff and Johnson (1999) reframe the notion of reasoning in western philosophy characterising it as knowing through metaphor which invariably transmits the bodily nature of our thought processes.

With this theoretical support, we can build a

different research path in design, not only to reframe the nature of the activity but also to understand what really emerges when designing. Is creativity in designing just a matter of emergence of new inspirational forms from which we verbalise new concepts? Or is it, rather, a matter of taking on the problem from a new perspective, which grants novelty to the outcome and, at the same time, through the use of simulation skills and tools, opens designers to the groundedness of the experience, which identifies its applicability? We can pose as a first hypothesis that the act of creation in design happens entirely at an experiential level, imagined or represented, and that the following rationalisation mainly serves as corroboration and social support. Another hypothesis is that the first steps in the design process, as they produce more abstract and diagrammatic representations, are metaphorical by nature because of the extreme indefiniteness of the problem and the consequent incompleteness of the experience. In this sense, the search for conceptual meaning is not connected to solution finding but to problem finding and, by being so, the originality may reside in the way we find problems and not in the way we generate solutions.

Acknowledgements

This research was funded by the Fulbright Program - USA and by the Fundação para a Ciência e Tecnologia - Portugal - PRAXIS XXI Program, Grant BD/11320/97.

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