

The impact of computer-based support on product designers' search for inspirational materials.

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Abstract

This paper considers the impact of computer-based support on the task of identifying inspirational materials as part of the process of creative product/commercial design. A model of creative design is presented. Using this as a basis, implications for the location of inspirational materials are examined. In particular, the value of structure and diversity in the organisation of retrieved information is explored. Relevant results from interviews with designers and laboratory tests of student designers are discussed. Implications are presented for of optimisation of computer-based support for this task.

Keywords: creativity, design

1. Introduction

The search for inspirational materials, and particularly images, is an important part of the process of creative industrial design. In this paper we explore key features of this task component and consider how it may be affected by the introduction of computer-based support. In doing so, we review relevant literature and draw on data gathered from interviews that we have conducted with designers (mostly car designers (n=22), but also a small number of designers from multimedia and graphic design (n=3), packaging (n=1) and furniture design (n=1)) [1]. We also refer to results from laboratory studies in which design students were asked to

perform keyword searches for images as a precursor to fulfilling an imaginary design brief [2][3].

In the following sections of this paper we first set the context by presenting a model of creative design. This is a synthesis of existing views of creativity and the design process (see e.g., [4][5]). It provides a basis for examining, in Section 3, how structure can be applied to the creative design process. In Section 4, the role of serendipity in the identification of creative materials is considered. In Section 5 the variability of requirements for computer-based support across different design disciplines is considered. Finally, in Section 6, conclusions are drawn.

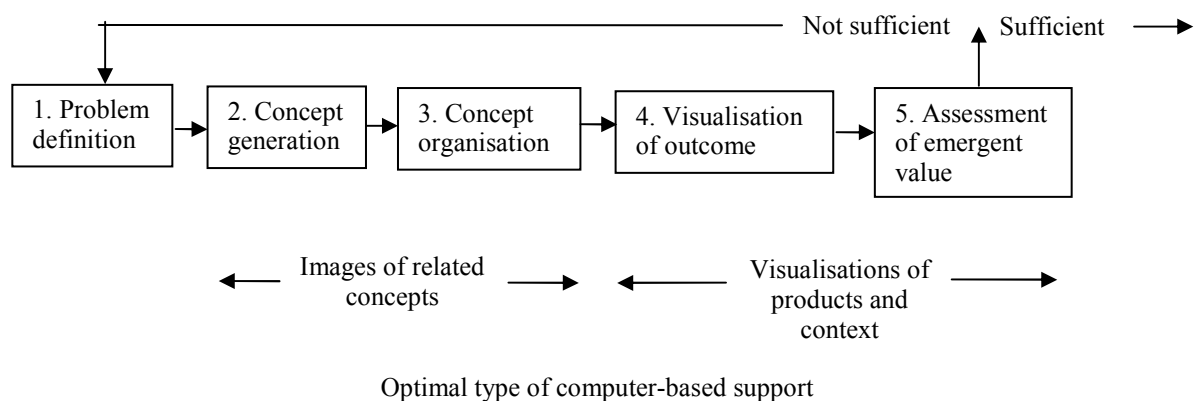


Figure 1. A five stage model of the creative process based on a synthesis of existing views.

2. The Creative design process

It is generally agreed that for a product to be considered creative it must be both novel and of value [4][6]. Various models of the process by which this can be achieved have been proposed. Here, we describe it in terms of five steps (see Figure 1). In Stage 1 the problem is defined. In the context of creative product/commercial design, this might take the form of a marketing department identifying a niche or a requirement to realign a product with regard to the marketplace. This could result in the development of a design brief that is provided to designers. However, problem definition need not be this explicit. Designers may develop ideas with few constraints, other than to satisfy a desire for aesthetically appealing or functionally effective/efficient products (e.g., [7]).

In Stage 2, concepts that may be relevant to the design are identified. These are the building blocks for a creative solution. Their identification can be achieved through search of *external* materials (e.g., magazines, image databases) or through search of the '*internal*' memory of the designer (see [4]). "Sources of inspiration play a number of important roles in design thinking, as definitions of context, triggers for idea generation, and as anchors for structuring designers' mental representations of design" [8]. Interviews that we have conducted with designers support this position, with reports of image boards being used to communicate ideas to clients and colleagues, and collections of images being gathered and used as reference points for designs. In Stage 3 these conceptual 'building blocks' are arranged, with novelty of solutions arising from the specific combination of concepts (an unusual context of application can suffice in this regard), or from contrast between concepts. Both the generation and combination of concepts can proceed in a random fashion, or be based on a set of rules, or a combination of both [4]. However, diversity, ambiguity [9], and even risk [10] are important to this part of the process. "To live a creative life we must lose our fear of being wrong" (J.C. Pearce: cited by [11]).

In Stage 4, designers visualise the outcomes of a specific configuration of concepts. This must be done with regard to a specific context of application. This enables them, in Stage 5, to evaluate the emergent value of the creative solution. McLaughlin [4] argues that selection of a design solution based on emergent value is "...a necessary and sufficient condition of a creative

process". If the emergent value is judged sufficient then the design process can be terminated. If it is not then iteration can begin.

From this we can conclude that the applied task of creative design will be most effective when a balance is achieved between the production of diversity and uncertainty at Stages 2 and 3 of the model, and the resolution of this in the form of a design solution at Stages 4 and 5. Our earlier definition of a creative product specifies that divergence from the norm is necessary but not sufficient to ensure a creative outcome. Designers must be able to recognise similarities between information retrieved and the problem domain (i.e., the design brief). Consistent with this, several current theories of creativity emphasise the need for both divergent and convergent thinking with an imbalance in either direction having potentially detrimental effects on outcome [12]. In this paper we are particularly concerned with Stages 2 and 3 of the model, but it follows that there are implications for other stages.

3. Structure and diversity

If the degree of creativity produced by a creative design process is related to the degree of divergence the designer can identify and resolve (i.e., the semantic distance between sources of inspiration that can be integrated to form a design solution), there are a number of task performance strategies, that can be adopted by designers, that structure materials to facilitate this. In this section we consider some of these.

The use of analogy is a central feature of many such strategies. For example, one approach is to search for analogies between the 'inspirational domain' and the 'task domain', i.e., to apply an existing solution in a novel context (see e.g., [13]). The difficulty associated with accomplishing this will be a result of the semantic distance between the two (see e.g., [14]). Related to this, when identifying inspirational materials, designers can search semantic domains that are different from, but associated with, the target domain. For example, our interviews with car designers have identified fields such as architecture and furniture as frequent sources of inspiration [1]. There are aspects of the aesthetics and functionality of design that are shared by each of these fields. In laboratory studies, when participants were asked to use semantic (keyword) computer search facilities to

locate inspirational images for a car design task, we have found they sometimes use one car-related keyword to ‘anchor’ their search to the design domain, but couple this with more semantically distant search terms (e.g., car + exciting + futuristic; bold + colourful + cars). This may produce a degree of diversity in results, but with results that are readily interpreted in terms of the task domain.

When considering analogical processes, nature is a particularly important source of inspiration for many designers [1][8][15]. “All art is but imitation of nature” (Lucius Annaeus Seneca: cited by [11]). Natural forms may have functional advantages, having evolved over long periods [16]. The study of ‘biomimetics’ is based on this premise: examining how designs can be developed using solutions that are present in nature. Use of analogy rather than duplication is thought to be the more successful route to take [17]. Such design solutions may also have aesthetic advantages perhaps arising from an economy of form [16]. However, Vogel [18] warns that we should be careful about being too quick to infer that designs are derived from natural solutions. Correlation is not causality. It may be that nature and designers have independently arrived at an optimal solution.

The identification of relationships between apparently diverse concepts is amenable to computer-based support. Although, to our knowledge, this has not been empirically explored in the context of creative design, a range of text analysis algorithms are available that can identify commonalities between texts that extend beyond shared keywords (e.g., Latent Semantic Analysis [19]). Given that image retrieval can be achieved on the basis of associated text this could be employed in this context. Of particular relevance are efforts to develop algorithms to identify links between apparently unconnected constructs as part of a discovery process (e.g., [20]).

4. Serendipity

The search for inspirational concepts, in Stage 2 of the model (Figure 1), can be based on rules, but can also be random or semi-random [4]. This provides for the possibility of ‘happy accidents’ in terms of retrieved results and creative outcomes. Computer-based support will tend to reduce this possibility. Computer-based information retrieval systems are designed to

produce results that are as semantically proximate as possible to the specified search terms. The goal is to reduce the ‘semantic gap’ between the search terms and the retrieved items [21] and achieve perfect recall and precision [22]. As a consequence, when computer support is used as part of the creative design process, random variation in results will be reduced or even ‘lost’.

The potential advantages of serendipity in locating items and identifying associations between items have recently been discussed in the context of computer-based information systems (e.g., [23]). Results of our interviews with creative industrial designers indicate that they recognise the value of serendipity and take advantage of it when the opportunity arises. The increased search power of computers, coupled with the potential for supporting decisions relating to the creative value of possible outcomes, may reduce the need for selectivity of materials at an early stage in the retrieval process (see Figure 1). It may become feasible for designers to consider a wider range of materials with no greater investment of time or effort. Nevertheless, this may not confer the advantages associated with diverse materials that are provided by serendipity (see above) and so the emergent value of outcomes may be less. Therefore it is worth considering how serendipity can be maintained as part of a computer-based image retrieval system.

One possible means is through the search strategy, either accidental or intentional, of the creative designer [24]. For example, a strategy that we have identified in the laboratory, when participants perform search tasks for inspirational images to support a design process, is the ‘under-specification’ of the search by using relatively few key words. In studies conducted with design students, 50% of the sample chose not to use the maximum permitted number (three) of keywords when defining their search. The consequence was that the focus of results was reduced and the potential for serendipitous retrieval increased.

When considering the organisation of concepts (Figure 1: Stage 3), a computer-based strategy designed to benefit from serendipity is described by Mete [6] in the context of ready-to-wear clothing. It involves designers superimposing images of two different fashion designs, one on top of the other (this is an example of a “homospatial process”). Inspiration arises from the combination of the two. According to Mete, Rothenberg [29] studied this in the context of the visual arts,

concentrating on a range of artists including Leonardo da Vinci, and found visual metaphors arose from “discrete entities occupying the same spatial location, superimposing and fusing them”. The approach was identified as influential in the thinking of da Vinci, with Rothenberg concluding that it produces analogical thinking, but also outcomes of which the designer is unaware.

Another way in which computer support for the design process can facilitate serendipitous identification of materials is described by Beale [23]. If results of a semantic (keyword) search are presented in the form of a multi-dimensional spatial-semantic visualisation (see e.g., [26]) that can be explored by the designer, this enables identification of co-varying properties in the retrieved items that had not occurred to them at the time of entering the search terms. In our interviews with designers, they have been enthusiastic about the possibilities of using semantic-spatial mappings of computer-based search results. The degree of control invested in the designer by such a system may be an influential factor.

In summary, the effects of introducing computer-based support to the task of identifying inspirational materials for the process of creative product design may be to reduce the extent to which serendipity is part of the process. Although computer-based support may mean that greater quantities of information can be located and evaluated, this is not necessarily a replacement for the diversity-related advantages of serendipity. However, there are strategy options that can be adopted by the designer to maintain an element of uncertainty in the search process, and there are display options that may be valuable in this regard.

5. Requirements of different design disciplines.

The sample of designers that we have interviewed is heavily biased in favour of car designers, and therefore we need to be cautious when making inferences about different requirements of different design disciplines. Generally, there was a good deal of consensus on major issues between designers, both within and between disciplines. However, there are also some potentially important differences in responses between design disciplines that are beginning to emerge that would influence the nature of the computer-based facilities required. For example, media/graphic designers want to be able to have

ownership of images that they locate, so they can use them in work that they produce. They currently use websites such as www.istockphoto.com that provide this facility. In contrast, this is not a requirement for many other types of designer.

For some design disciplines, fashion trends are largely determined by industry leaders, rather than the consumer. For many packaging/product designs, due to the long lead time on product materials, decisions need to be made well in advance. Moreover, particularly for smaller design agencies, it can be commercially risky not to ‘stay with the pack’ in terms of design trends. Doing so also means that materials are more readily available and at a cheaper price. For these designers inspirational materials need to reflect these predetermined trends.

The integration of multi-sensory materials is more important for some design disciplines. In large part this is determined by the nature of the materials involved in the design. For example, in the context of the design of car interiors designers have told us during interviews that swatches of material are an important source of inspiration. For other industries, e.g., the fashion industry, tactile properties of materials could play an even larger role (see [15]). However, this is not an insurmountable problem for new technologies. Computer-based systems do not need to replace all existing aspects of the design process. They simply need to be able to integrate with those that remain unchanged.

6. Conclusions

The task of creative industrial design places particular demands on computer-based search facilities. For example, what is normally considered to be an effective information retrieval algorithm (i.e., producing high precision and recall, and closing the ‘semantic gap’) may be one that is rather poor for serendipity, and thereby creativity. Detailed empirical evaluation of this effect would be useful, with consideration of both optimal variability in search results (‘noise’) and also optimal shape of distribution (e.g., a few outlying values may be sufficient for this purpose). In the context of the proposed model of creative design (see Figure 1), computer-based support may change the relative emphasis on different components. Search is facilitated by computer support, and potentially so is the visualisation of different

solutions. As a consequence designers could consider a wider range of materials. However, this is not to say that they will have the same emergent value [4]. In fact, there are reasons to believe this may not be the case. For this reason it is important to consider the search strategies that designers have at their disposal to induce both structure and serendipity into the process. There are also computer-based methods, e.g., spatial-semantic mappings of search results, that would assist in this regard.

In conclusion, computer-based support for the task of identifying inspirational materials for the creative product design task may enable access to large quantities of visual and textual materials, along with powerful search and analysis. However, there are aspects of the creative process that may not be well suited to traditional computer-based approaches to information retrieval. Moreover, access to tactile materials is problematic. There are implications that follow for the training of designers in the use of computer-based facilities. However, it is important that the development and application of computer-support systems is undertaken with a clear view of the specific and unusual requirements of the design task.

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