Computer support for creativity: help or hindrance?

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Introduction

Enhancing the conditions within which creativity is likely to be exercised is clearly very desirable. In this paper we consider the nature of creativity and the extent to which computers can assist the creative process. A general model of creativity based on the notion of "divergent" thought, is elaborated and illustrated. The validity of this model is then tested within a particular domain, electroacoustic music composition. The results of two studies are considered, the Tema project (Eaglestone 1994), in which a case study composition is analysed in depth, and a survey by Clowes (Clowes 2000) in which the attitudes of composers to current composition software is surveyed. It is concluded that these two studies largely support the validity of the authors' model of creativity.

The notion of "creativity"

Creativity is often described as “divergent” as opposed to “convergent” thinking, the latter being associated with relatively predictable logical activity and outcomes, the former with less logical and predictable activity and outcomes.

To take a simple example: early pioneers of flight, presumably initially working by analogy with bird flight, tried to devise effective flapping wings—a relatively convergent approach. The breakthrough was: to conceive of a solution in terms of a fundamental reconfiguration of elements of the problem—i.e. to drive air over a fixed wing—a relatively divergent approach. The term "relatively" is important here, since a further breakthrough may diverge from the relatively convergent idea (now that it is in common currency) of driving air over a fixed wing. The extent to which an idea may be thought of as "creative" is time- and context- dependent.

Often descriptions of instances of creative thought suggest a sudden perception or realisation—a flash of insight when things come together—occurring when the person is not intensely focused on the particular problem. Classic examples include Kekule’s discovery of the ring structure of benzene. He saw in a dream snakes seizing their own tails and “awoke as if by a flash of lightning”. Some of the most vivid have concerned mathematicians. Often, having struggled with a problem and then put it aside, mathematicians find that the solution comes to them quite unexpectedly, in a flash. As Gregory (1987 page 171) has noted: "…our brains are at their most efficient when allowed to switch from phases of intense concentration to ones in which we exert no conscious control at all.”

Perception versus logic

De Bono (1987) has described the first stage of thinking as the perception stage—how we look at the world; the concepts and perceptions that we form, and the second stage of thinking as the processing stage—what we do with the perceptions. He considers that logic can only be used in the second stage since it requires concepts and perceptions to work upon.

Whilst the logic of a creative idea must still be worked through in procedural detail before it can be tested out, refined and successfully applied, some initial “flash” of recognition is required.

Indeed, logical thinking may in certain circumstances hinder the initial processes of creative thought. Talking essentially of creative flashes of insight, Strauss and Corbin (1997 page 29) suggest that:

> Only under certain conditions will those insights arise... [Questions and answers] are raised and sought even if on a subliminal level of consciousness, and sometimes for quite a time, before the vital question or answer breaks through to consciousness. ….the investigator ... has to escape the very features of his or her work that may ... block the new perspective inherent in the sudden hunch, the flash of insight, the brilliant idea, or the profoundly different theoretical formulation. Specific knowledge, alas, ... at times constitutes mental baggage that impedes this kind of intellectual creativity.

To the extent that perception requires spatio/visual parallel processing and logic requires verbal sequential processing, then divergent and convergent thinking may to some extent map onto hemispheric brain differences.

The role of computers

It may at first sight appear that computers are irrelevant to creativity in that they are better at convergent than divergent information processing tasks, therefore having little if any role to play in supporting creative thinking.

However, paradoxically so-called divergent thinking does in fact proceed to a significant degree via essentially convergent though processes, in that one of its central features is the identification of similarity relationships. Creative thinking entails convergent processing in that it entails generating new ideas by identifying themes by which otherwise discrete entities become integrated. Such integrating themes are essentially similarity relationships between concepts.

Divergence is also important—but it relates to context and/or content (not process) of thought. It is also important in that the level of creativity enabled by such identification is dependent on the type and level of dissimilarity applying to the context and/or the nature of the discrete entities integrated by the similarity relationship.

The level of creativity is also dependent on the level of abstraction of the entities concerned. Thus, finding a document in one field of study which shares several keywords with a document in some other field of study is unlikely to stimulate a creative new direction of thought. But identifying a common problem-solving structure underlying the solution of apparently very dissimilar problems in different fields may be more likely to do so.

The identification of themes capable of integrating entities which are relatively similar to one another, and/or between entities which operate at relatively low levels of abstraction, relates to concept formation and learning in general—that is, at levels that do not necessarily entail creativity. It is the extent of dissimilarity and the level of abstraction that differentiate creative from less creative forms of thinking.

Arguably, to provide relatively direct computer-based support for creativity (as opposed to the more indirect form of support currently available), we need further to develop knowledge representations and processes (a) at a high level of abstraction, (b) entailing perceptual (spatio/visual) pattern recognition and matching to complement logical processing, and (c) entailing some element of randomness and serendipity—i.e. an element of "non-control."

Creativity in Electroacoustic Music Composition

Electroacoustic music composition provides an interesting instantiation of the creative process discussed above. Composers forever seek innovation in the form of original compositions, styles and techniques. Thus they strive to distinguish themselves from all other composers. Further, the music community has embraced new technologies throughout the ages, recent examples being the use of electrical recording technologies to create ***musique concrète***, the use of computer signal processing to synthesise and transform musical sounds in composition and performance, and computer-assisted or algorithmic composition—see Roads (1985) for a range of composers' perspectives on the use of computers in composition.

Two studies, of the music composition process (Eaglestone 1994) and of attitudes of composers to computer-based composition tools (Clowes, 2000), provide evidence against which to test the above model of creativity, and also to examine the apparent mismatch between current computer software and the aspirations of the creative worker. In particular, they partly reinforce our above conclusion, that enhanced support for creativity may be achieved through high-level abstract knowledge representations and processes, with perceptual (spatio/visual) pattern recognition and matching, and a capacity for randomness and serendipity.

The *Tema* Project

The ***Tema*** project (Eaglestone 1994) was a study of the composition methods used in the creation of ***Tema***, a piece of electroacoustic ballet music composed in 1986 by Tamas Ungvary to accompany choreography by Peter Raijka. Both music and choreography were created using the NUNTIUS music-dance system (Ungvary, Waters & Raijka 1992). NUNTIUS is a file-base system with subsystems for both composer and choreographer, and architectural features and interfaces to allow them to work co-operatively. The composers' system comprises a library of software tools with which sound may be created, manipulated, analysed and auditioned. However, NUNTIUS lacked direct support for the creative process, as is typical of current composition systems (see proceedings of the International Computer Music Conferences).

Ungvary provided unique insights into the creative process by keeping a detailed diary throughout the composition process. The diary provided both technical and "human" details. All computer interactions with NUNTIUS were recorded, together with the motivations and method behind each program evocation. This unique document therefore provides a rare and sharp illustration of a composition process. The scope of this study was clearly limited, since it is impossible to generalise from a singe case study how composers compose, or even how Ungvary composes. However, given the rarity of such material, the exercise does provide some valuable insights.

The case study diary was analysed using methods normally associated with software engineering (Chroust 1989). Transformations were analysed to identify objects, events and transitions. Activity descriptions in the diary were generalised, and finally an object-oriented conceptual model was derived. In this way a conceptual model was produced to act as a general framework for a particular style of composition.

The analysis was from the perspective that there are similarities between artistic design and engineering, and therefore features of engineering support technology may be usefully adapted for use by artists. However, it became clear from the study that intuition rather than methodology directed the composition process. However, Ungvary made also use of methodical techniques, such as problem decomposition (***Tema*** was composed in sections) and the design method was phase-oriented (sounds were assembled, then textured and reverberated).

Thus the above model of creativity in which methodology and inspiration are applied in tandem was illustrated. The analogy apparent was that of a painter mixing materials to form new colours and then applying them to the canvas to form the artwork. It was also apparent that transitions between object states were of interest as well as the objects themselves. These constituted the composition techniques, which were reused when results were satisfactory. This reflected the experimental nature of the creative process. Ungvary was often "feeling for" that which worked, through trial and error, rather than simply implementing his conception. As Ungvary stated, "Errors will often produce the most artistically interesting results!" (Ungvary, personal communication), thus confirming the importance of randomness and serendipity in our above explanation of creativity. Finally, we observed that both materials and techniques were frequently reused. This reflects an aspect not identified in our model of creativity, i.e., that of accumulating individual and community know-how which provides both knowledge of resources and proficiency in using the tools and techniques.

In addition to the above analysis, it was also observed that Ungvary experienced problems of object and process management, similar to those that are effectively addressed for engineers by their support systems. He experienced difficulty in keeping track of and retrieving objects, and in operating the various user interfaces that had to be navigated. These problems are a distraction from the creative process, and enhanced object and process management support is likely to be beneficial.

The results of this initial study (Eaglestone et al 1993), were an object model of the composition process, and a prototype support system with abstract workspaces configurable to fit different ways of working and a repository of artefact versions, processes and techniques. In particular, these aimed at better support for ad hoc experimentation, by retaining versions of objects and recording the processes applied. Also, the data model used reflected our conception of creativity as a divergent process, since it allowed high level design objects (e.g., sounds, tools, etc) to be associated by events, in an ad hoc manner.

A Survey of Electroacoustic Music Composers' attitudes to Composition Tools

The second study (Clowes 2000) was a follow-up to the ***Tema*** project, in which attitudes of composers to current electroacoustic music composition tools are surveyed. The motivation was to review the findings of the Tema project, in light of technological advances that have taken place throughout the 1990s, and also to broaden the scope of the study. Whereas the ***Tema*** project provided an analysis through an in-depth study of a single case study, Clowes attempted to test the general validity of its conclusions by surveying a wider population of composers. The study methodology included in-depth interviews, questionnaires (returned by 30 composers), and the mining of Internet-based discussion groups for electroacoustic composers to identify patterns of issues raised.

Clowes anticipated that composers would be predominantly intuitive or methodological, and the latter would experience greater frustration with current composition software if it did not enable them to apply their predetermined methods. In practice the composers surveyed rejected this crude classification. The consensus was that composition is a mix of intuition and methodology. One alternative classification proposed on an internet mailing list for electroacoustic music composers (cecdiscuss) was of "pure realisation" and "voyage of discovery", which relates also, for example, to those traditional composers who transcribe the conception straight to the score and those who "doodle" at the keyboard, seeking ideas and inspiration.

The importance of randomness and serendipity was also reinforced. A number of composers saw the limitations of current composition software an advantage, since, for example, constraints forced ingenuity and innovation. Also, they enjoyed working with environments which "suggested" unexpected possibilities. The ability to play and experiment was therefore a very important feature. Interfaces to composition software were an issue. Frustration with limitations was apparent, in that many of the composers surveyed had developed their own software and novel hardware interfaces.

Discussion

In both studies there are illustrations of where the unexpected is deliberately sought and valued. This may occur, for example, because of an error or unfamiliarity with the system being used. Thus, the composer may be said to exhibit divergent information-seeking behaviour as he or she reaches for the "correct" musical artefact. Convergent behaviour would be one of explicitly selecting a sound, for example, and then refining it to meet artistic requirements.

Ungvary's diaries suggest that identification of the "correct" artefact is often made through protracted consideration, rather than by "flash of inspiration", and Clowes' survey throws no further light on this. Also, the studies do not provide any evidence of "spatio/visual processing" as an aid to creativity, though the composer's frustration with conventional software interfaces — apparent in the attitudes of the composers surveys, and in Ungvary's later work, for example, on the "sentograph" (Vertegall & Ungvary 1995)and the "composer's cockpit" (Ungvary & Kislinger 1998) — suggest a need for more direct, tactile means of seeking and manipulating sounds in composition and performance. There was also evidence of the importance of methodological working to render and refine the inspirational conception, for example in Ungvary's structured approach to building and refining Tema.

The types of computer support for creativity hypothesised in the first part of this paper are high level abstract knowledge representation and processes, with (spatio/visual) pattern recognition and matching, and some element of randomness and serendipity. The latter is clearly desirable, and the studies showed evidence that it is already sought in current systems, for example, by utilising the errors(!) and unfamiliar software. The Tema project defined enhanced knowledge representations, better to model the type of composition process analysed. These were implemented in a prototype system (Eaglestone et al 1993), but have yet to be validated in real compositional activities.

This is a rich area for further research. We believe that there are potentially great gains to be made through the provision of repositories to support creative activities, which not only model the materials and tools being used, but also the relevant processes and know-how. The studies provide no evidence about the value of vision/spatial facilities for matching artefacts at a high level of abstraction. Certainly, randomness and serendipity are important, but the visual/spatio mechanism proposed presupposes that the high-level similarity criteria can be explicitly stated a priori, and ranged over heterogeneous collections of pre-indexed artefacts. However, there has been research in related areas within electroacoustic music composition, for example, by creating multidimensional-spaces of sound with tactile search facilities and direct manipulation.

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