UC Merced
Proceedings of the Annual Meeting of the Cognitive Science Society

Title
Sketching Musical Compositions

Permalink
https://escholarship.org/uc/item/3kc0t66r

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 29(29)

ISSN
1069-7977

Authors
Healy, Patrick G.T.
Thiebaut, Jean-Baptiste

Publication Date
2007

Peer reviewed

eScholarship.org Powered by the California Digital Library
University of California

Sketching Musical Compositions

Patrick G. T. Healey (ph@dcs.qmul.ac.uk)
Department of Computer Science, Queen Mary, University of London
Mile End Road, E1 4NS London, United Kingdom

Jean-Baptiste Thiebaut (jbt@dcs.qmul.ac.uk)
Department of Computer Science, Queen Mary, University of London
Mile End Road, E1 4NS London, United Kingdom

Abstract

Sketches form an integral part of activities ranging from games through explanatory dialogues to doodles. They are also known to be important in the creative stages of design. This paper explores the role of sketching in musical composition. We discuss the historical correlation between changes in graphical notations for music and compositional practice. Contemporary music technologies provide powerful graphical notations that double as control interfaces. Nonetheless we present survey evidence that sketching still plays a key role in the creative process even amongst technically literate contemporary composers. A detailed case study illustrates how sketching supports a dynamic interplay between drawing spaces, semantic frames and compositional frames that aids revision and re-interpretation of musical ideas.

Keywords: creativity; sketching; music; composition;

Introduction

Informal drawing or 'sketching' forms an integral part of a variety of everyday activities. For example van Sommers (1984) found that sketches play an important role in e.g. games, maps and route directions, developing explanations, and designing kitchens and clothes. Drawings in these contexts can serve a range of cognitive and computational functions (Scaife and Rogers, 1996). For example they can provide a useful way to articulate multiple, parallel constraints that are difficult to express in natural language, such as the relative position and orientation of groups of objects. More generally they can help to reduce memory load and provide external representations that simplify the computational and cognitive demands by distributing the information processing (Hutchins, 1995; Norman, 1993).

In some specialized contexts graphics have developed into full diagrammatic systems, such as Euler circles, with rules of well-formedness and a clearly defined semantics (see e.g.; Stenning and Oberlander, 1996). These properties are especially important where the graphical representations also function as a programming language. For example, contemporary music applications use graphical representations, including standard musical notation, as a control interface for the music (see Figure 2).

Although a well behaved syntax and semantics are essential for computational applications there is evidence that some of the benefits of sketching derive specifically from their relative ambiguity and vagueness (Goldsmidt, 1991; Purcell and Gero, 1998). For example, Neilson and Lee (1994) showed that the relatively underspecified semantics of architectural design sketches is integral to the way they are used. In their analysis of kitchen design dialogues they found no consistent mapping between the dimensions of the page and the represented domain. A table might be drawn with width and depth and beside it a chair represented by a single 'one-dimensional' line. Moreover, a line that initially indicates the position of an object could subsequently be reinterpreted as a representation of a line of sight or a trajectory through the space.

Goldschmidt (1991) describes this dynamic interplay between design ideas and sketches as a 'dialectic' and argues that it is a characteristic and key part of the creative phase of design (cf., Purcell and Gero, 1998; Suwa and Tversky, 1996). There is evidence that one reason for this is that sketches, as external representations, are more readily reinterpreted than mental images thus facilitating the exploration of design ideas (e.g., Chambers and Riesberg, 1985).

Empirical studies of design sketching, like those cited above, are striking partly because they focus on domains (such as architecture or product design) in which there appears to be a relatively straightforward mapping between the sketch space and the world. Here we focus on a more abstract domain, music, in which key dimensions – such as aesthetic or temporal structure – have a more obscure relationship to the sketch space.

We begin by considering how the form and function of music notations have evolved over time. We then focus more specifically on the use of sketches in the early phases of composition. Using evidence from a small survey and a case study we explore the interaction between the development of musical ideas and the properties of the media used to represent them.

The Emergence of Musical Notations

Conventional music notations evolved primarily to support teaching and documentation not composition. The first neumatic notation, which emerged in monasteries in the 9th century, consisted of a free form line, usually above a text, which represented pitch (see figure 1).

The first lattice-based representation of music, combining neumes with a 4 line stave, is attributed to Guido d'Arezzo in the 10th century. D'Arezzo invented this notation as a mnemonic aid for teaching chant to his students. These

notations were designed to reduce the introduction of accidental changes due to oral transmission of pieces. However, they also altered the task of composition. They provided composers with an abstract representation of music that could substitute for the music itself.

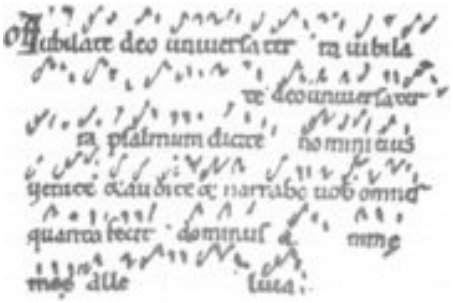

Figure 1: Example of early neumes

A number of historical changes in musical form correlate with innovations in notational systems. For example, musical ideas such as polyphony and counterpoint co-evolved with the changes spatial arrangement of notes vertically (polyphony), or the specification of note durations (counterpoint) (see e.g., Burkholder, Grout and Palisca, 2006 for an overview). There are also many anecdotal examples of musical ideas that developed as a result of experimentation with different notational formats. For example, the geometric character of the symmetric or reverse process used by J.S. Bach, A. Schoenberg's serialism or the formalized music of Iannis Xenakis (1992).

Notations as Control Interfaces.

Notations have gradually evolved to include instructions for performance. For example, representations of dynamics and also playing modes (such as *flatterzunge*, a way of blowing in a flute) and improvisation. The notation of playing modes specifies abstract gestures rather than concrete sounds. This is significant because it treats aspects of the performance of a piece as parameters that can be controlled. Some scores explicitly locate musicians in a concert hall, notate the sounds to be played by a tape, or even include schematic representations of electronic devices used to transform sound.

The potential of computers to enhance control of musical structure was appreciated early on. Max Matthews' Music I, an influential program for sound generation was developed at Bell labs in 1957. Contemporary technologies employ a rich variety of graphical user interfaces for editing and mixing sounds and instruments. For example Rosegarden (Figure 2), a free music program similar to Cubase and Nuendo uses a time line paradigm inherited from d'Arezzo to represent sounds and symbolic data. Part of the interface represents sequences (shown in the upper right). Another part supports editing.

Despite the increasing control these user interfaces offer over musical form studies have shown that they provide little effective support for creativity (e.g., Dannenberg 1993; Abrams et al. 2001; Eaglestone et al. 2001; Dahan 2005). An obvious hypothesis that follows from the work on sketching in design is that this is because they require too much commitment, too soon, to the precise form of a piece (cf. Green, 1989).

In order to get a better understanding of the use of visual representations during musical composition we carried out a short survey of compositional practices among technically literate contemporary composers.

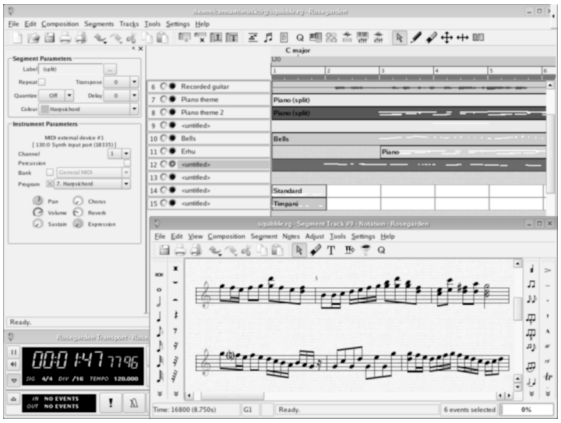

Figure 2: The Rosegarden User Interface

Practices in Contemporary Composition

The aim of the survey was to get a better overview of the typical first steps in composition, the role of technology, instruments and other artifacts and to assess the importance of sketching for music composition.

A short online questionnaire was prepared and calls for participation were distributed to mailing lists that target computer literate composers (Canadian Electroacoustic Community, Max/MSP, Arsonora and MySpace). These fora were targeted to ensure that respondents had high levels of technical competence.

Composers were invited to answer the online questionnaire[1] and to submit copies of any drawings or images they produced during composition, where available. A total of 32 composers responded over two months.

Across the sample, the most common media used for initial composition were pen and paper. 24 composers (75%) reported using pen and paper in the first stages of composition; 16 (50%) reported using pen and paper exclusively. 5 composers reported (15.6%) using a computer at this stage and only one composer started by interacting with an instrument.

The most commonly reported initial representation of a piece was a drawing (50%). Six participants reported starting from an idea or mental representation and the remainder used either a textual description (3) text plus visuals (3) or nothing (6).

The general pattern suggested by these responses is that the initial stages of composition involve the manipulation

[1]See http://www.dcs.qmul.ac.uk/research/imc/sketches/

higher level concepts or representations of music, not the concrete particulars of the sounds. Most of the composers in the sample begin with an abstract idea or concept of the composition. For 13 (40%) of the sample this corresponds to a concept of coarse grain musical structure or states, for 8 (25%) it corresponds to temporal patterns or dynamics. In most cases these concepts are rendered in a visual representation of some kind. In contrast to this only 5 people in the sample develop the first stages of composition using specific sound parameters. 20 participants (63%) reported beginning with only vague details of the final piece.

Overall, the results suggest that the initial stages of composition involve processes similar to those described for other forms of creative design (e.g. Purcell and Gero, 1998). Participants start with a vague conception of what they want to do and, in the majority of cases, develop them through an iterative 'dialectical' processes of sketching and revision (cf. Goldschmit, 1991).

Case Study: Sketching a Composition.

In order to get a deeper understanding of what sketches can contribute to the composition process we carried out a detailed case study of the drawings produced by one questionnaire respondent: Samuel Freeman, a contemporary composer. His work was used because he had retained all the sketches produced for a single commission.

The data reported below come from Freeman's own notebooks and from two interviews exploring how the drawings evolved as the composition developed.

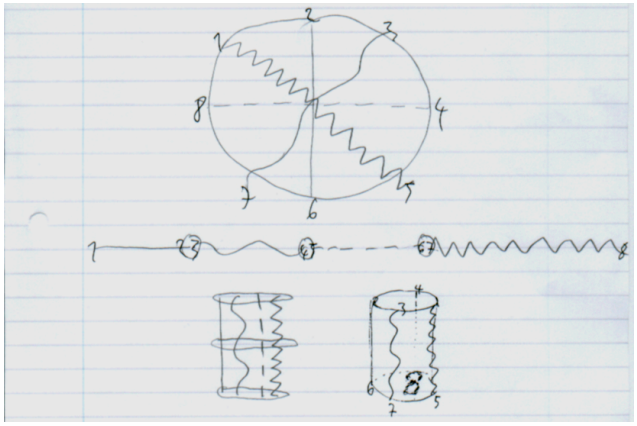

Figure 3: Freeman sketch 1

The commission was to produce a composition for 8 channels of audio. A total sequence of fourteen pen and paper sketches were produced in the course of this composition. Here we consider the developments across the first six of these sketches

The circle at the top of sketch 1 represents a spatial arrangement for eight numbered speakers. The lines between them represent possible pairings of the speakers. The form of the lines - solid, dashed, undulating – are used only to distinguish the identity of the pairings not their form or auditory qualities. The middle line in sketch 1, produced next, represents a possible translation of the initial spatial arrangement into a sequence of pairings that could be rendered on a stereo channel. The final to sketches represent a mapping of the four pairings into a three dimensional auditory display.

The starting point for Freeman's composition is thus an exploration of possible spatial configurations for displaying 8 channels of audio. This occurs prior to any consideration of what will be rendered in the different channels.

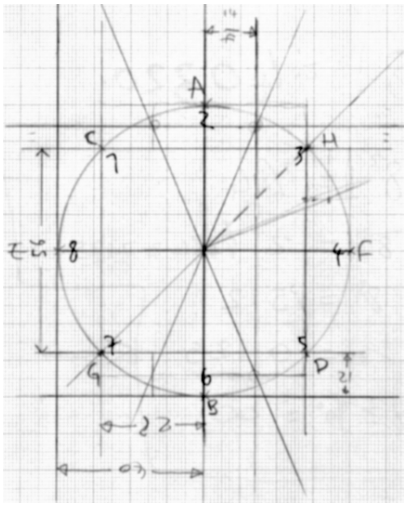

Figure 4: Freeman Sketch 2

In sketch 2 the circular speaker array recurs but Freeman's primary concern here is with the numerical relationships that can be constructed from the geometry. The circle is drawn with a diameter of 8 cm on graph paper. The speakers are treated as geometric points. Some of the angles are bisected, chords drawn across the circle and extended into secants to find points of intersection. The distances between some of these lines are noted in pencil. This sketch is focused on finding a set of interrelated numbers, indirectly anchored in the original concept of 8 channels, that can be used as numerical parameters in the composition.

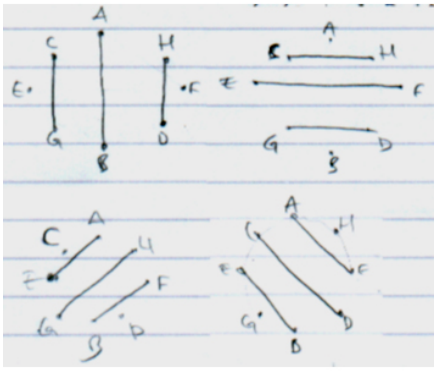

Figure 5: Freeman sketch 3

The next sketch in the sequence returns to the pairings of speakers (Figure 5). The lines have now evolved from being

'graphical labels' for pairings of speakers to become maps of possible locations between speakers where sounds will be projected. The four panels in sketch 3 indicate how different configurations of these spatial arrangements will be simultaneously overlayed. This drawing emerged in part from the need to consider how this display could be implemented in Max/MSP. Although ostensibly spatial this sketch thus doubles as the architecture for a proposed 3D panner.

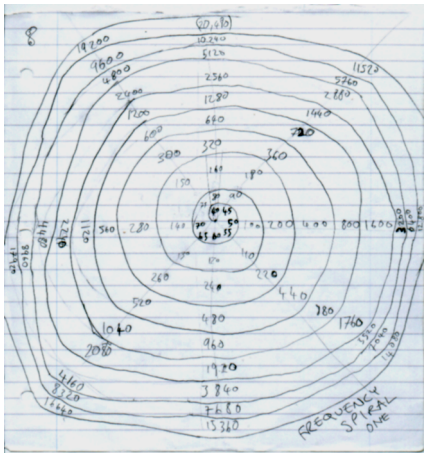

Figure 6: Freeman sketch 4

In sketch 4 (Figure 6) two innovations occur. For the first time a musical space, consisting of frequency intervals, is drawn. In addition a spiral structure is introduced. Here Freeman is calculating the pattern of intervals needed to construct 'nontaves' (as opposed to octaves) in which eight stepwise increases in frequency lead to a doubling – i.e. a repetition of the same note on the ninth step. The radii represent eight notes that get higher as we move outwards along the spiral. Notably, the circular pattern is retained from the previous sketches but used to depict the evolution of the sound rather than its location.

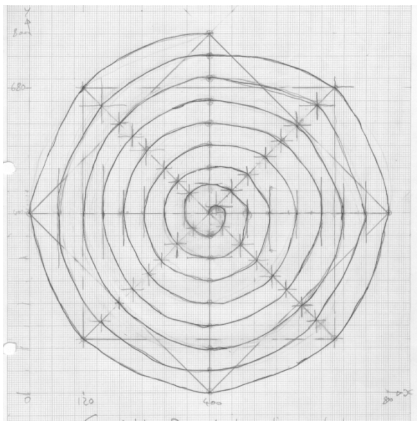
Figure 7: Freeman sketch 5

In sketch 5 (Figure 7) the frequency space is superimposed onto the spatial array created by the speakers. Graph paper is used to ensure an accurate mapping of frequencies to co-ordinates. This sketch also doubles as an architectural drawing in the sense that the pairs of values it specifies it became a look-up table in the protoype Max/MSP program.

The next drawing (Figure 8) was produced as part of a process of reflecting on the overall architecture of the composition up to this point. Here Freeman abstracts away from the details of the mappings he has created to consider the overall structure. The speaker positions are now represented by the double lines. Interestingly a 'figure-ground' reversal has occurred with the segments between the speakers - not the lines between them - highlighted as shaded areas.

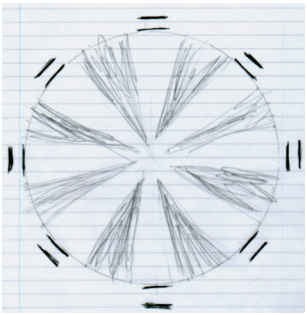
Figure 8: Freeman sketch 6

At this point in the development of the composition a prototype Max/MSP system was built and tested. This revealed that, although sounds could be effectively rendered at positions on the circumference of the circle, it was difficult to discriminate between locations of sounds within the circle. As a result of these problems with the rendering the focus of the composition switched to mapping possible sequences of channels.

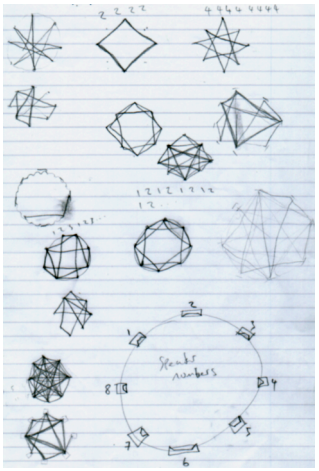
Figure 9: Freeman sketch 6

Sketch 6 (Figure 9) shows a series of drawings that explore variations in sequences of channels (speakers). The lines across the circular array of speakers now indicate order of playing. In some cases these patterns are annotated by numbers of 'steps' around the circle that will generate each

pattern (e.g., 1,2,1,2 in the centre of the page). This eventually led to the development of patterns that repeated after 8 or 16 steps and which became lists of integers used by the program.

It is useful to consider one further sketch produced for this composition (Figure 10). It is not clear exactly when it was produced and it is not an integrated part of the sequence described so far. Rather it was produced "in parallel" when the problems with the prototype were identified. This drawing resulted in part from frustration at being too "hung up on the numbers" and a desire to for some "less concrete" representation of the piece.

At this point the composer had produced a complex Max/ MSP system that was, in his opinion, musically uninteresting. In response to this Figure 10 was produced in an attempt to sketch the aesthetic abstractions, textures and transitions over time that the composer was seeking to create. This drawing was subsequently used to guide the structure of the composition for the rest of the piece.

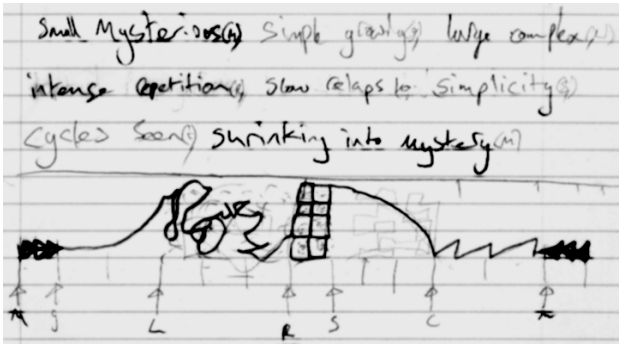

Figure 10: Freeman textures and transitions sketch

Each musical event is represented with a specific color, a form and a text. The text refers to the composer's personal musical references with adjectives such as "small mysterious" or "large complex". Colors –which were added later in photoshop- code the spectral progression and, in conjunction with the letters, provide a cross-reference between the forms and the text.

Discussion

The survey and case study both suggest that, as in other forms of creative design, sketching plays an important role in facilitating the development of ideas in musical composition. It appears that this is partly because people start out with relatively underspecified concepts of what they wish to achieve and partly because of the way sketches facilitate reinterpretation of ideas. It seems that sketches provide a suitably underspecified representation that helps composers to avoid premature commitment to the concrete details of a piece (cf. Green, 1989). Analysis of the case study highlights several aspects of the sketching process that go beyond the generic advantages of an underspecified representation.

First, the sketches produced by Freeman involve a variety of different semantic frames. Although initially concerned with spatial relationships the successive sketches explore: the structure of the audio display space; the space of geometric-numerical possibilities; the frequency or 'nontave' space; the temporal space and, in Figure 10, the aesthetic space of the composition. In all but the last of these variations the pictorial devices of circles and chords between points recur but with different interpretations. For example, the lines between points on the circle begin as markers of identity, then change to encode numerical relationships, then spatial vectors, then musical vectors, then temporal sequences (cf. Neilson and Lee, 1996).

This reuse of the circle and line arrangement highlights the influence of medium on the form of the sketches (cf. Tversky, 1995). The 2D structure of the page naturally affords planar shapes and it is interesting that the 3D shapes considered in sketch 1 do not recur. It seems likely that the affordances of pen and paper themselves constrain the kinds of creative solution that emerge. In this respect it is interesting to note that observations of architectural design dialogues have found that people work to create complex hybrid sketching spaces. These combine multiple pieces of paper, iconic and integrative gestures and verbal descriptions in order to construct 'virtual' three dimensional sketches suited to the domain (Healey and Peters, 2007).

A third point highlighted by the case study is the way the sketches switch back and forth between these different semantic frames as the composition proceeds. In fact, individual drawings sometimes combine aspects of different semantic frames in a single sketch (e.g., sketch 2, sketch 5). This entails that, for example, the x and y axis cannot be given a consistent interpretation.

In addition to switching between semantic frames the drawings also switch between different levels of detail. Sometimes dealing with specific sets of parameters, sometimes providing an overview (e.g. sketch 1, sketch 5 and Figure 10). This movement between semantic frames and levels of resolution suggests a simple 'monotonic' view of progression from underspecified sketches to progressively greater levels of detail is incorrect.

A final point highlighted by the case study is the significant practical work done by the composer to reconcile the representations of the basic concepts and ideas in the sketches with the kind of input formats suitable for programming Max/MSP (e.g., sketch 3 and sketch 5). Although the initial concern with numeric spaces originates from the brief in the commission to compose for eight channels, it evolves into an exploration of possible parameters for the program (e.g., sketch 2, sketch 6). In the case study the need to interface with the Max/MSP program acts as a constant and sometimes frustratingly restrictive influence on the process of composition. Leading at one point to a switch to an abstract aesthetic space (Figure 10).

Conclusion

These observations underline the key role that sketching has in creative activity. They show that even for technically literate composers, who use relatively sophisticated computer music and digital signal processing tools, it is an important, although not essential, part of composition.

Part of the interest in this finding is because, unlike studies of sketching in other forms of creative design, this is not an inherently visual domain. It is also arguably more complex in terms of the dimensions of the solution space. Graphic design sketches are concerned with producing something that is typically two or sometime three dimensional. Architectural sketches work towards the representation of a three dimensional domain. Music by contrast has a range of relevant non-spatial dimensions e.g., pitch, timbre, intensity, tempo, rhythm and, intuitively at least, seems less well suited to sketching on a piece of paper. It is also interesting to note that sketching of this kind is not normally taught in composition studies.

Nonetheless, it is clear that contemporary composers make significant use of sketching. In our case study the composer's desire to explore a variety of spatial, geometric, 'nontave', temporal and, ultimately, aesthetic ideas was most effectively supported by pen and paper. Moreover, the software tools available to him appear to have compromised the process of composition through the need to convert the sketches into the particular syntax and semantics required by the software.

Sketching supports a degree of vagueness and ambiguity that facilitates the creative processes involved in the early stages of design (Purcell and Gero, 1998). It allows a dynamic interplay between drawing spaces, semantic frames and compositional frames that supports revision and re-interpretation of ideas. Contemporary computer music tools do not support this process and, we propose, it is for this reason that they do not provide effective support for creative composition (Dannenberg 1993; Abrams et al. 2001; Eaglestone et al. 2001; Dahan 2005).

This is not to claim that the ideal situation for creative composition is one in which there are no constraints (contra Dahan 2005). It is also not to claim that pen and paper are the ideal creative medium. As noted above, pen and paper are better suited to some forms of representation than others. Our claim is that sketching fulfills a characteristic need of the first stage of a composition to design the global structure of a piece. We need a better understanding of how this process works. A good test of this understanding will be whether we can use it to build tools that provide more effective support for creative composition.

References

Abrams, S., Bellofatto, R., Fuhrer, R., Oppenheim, D., Wright, J., Boulanger, R., Leonard N., Mash D., Rendish, M., Smith, J., (2002). QSketcher: An Environment for Composing Music for Film, *in Proceedings of the 4th Conference on Creativity & Cognition, London, UK.*

Burkholder, P., Grout, D. and Palisca, C. (2006) *A History of Western Music*, 7th ed. New York: WW Norton & Co.

Chambers, D and Reisberg, D. (1985) 'Can mental images be ambiguous?' *Journal of Experimental Psychology: Human Perception and Performance.* 11, 317–328.

Eaglestone, B., Ford, N., Nuhn, R., Moore, A., Brown, G. J., (2001) Compositions Systems Requirements for Creativity: What Research Methodology?*, Proceedings of Mosart Workshop on Current Research Directions in Computer Music, Barcelona, Spain.*

Dahan, K., (2005). Domaines Formels et Représentations dans la Composition et l'Analyse des Musiques Electroacoustiques. *PhD thesis, Paris.*

Dannenberg, R. B., (1993). A Brief Survey of Music Representation Issues, Techniques and Systems. *Computer Music Journal.*

Goel, V. (1995) Sketches of Thought. MIT Press, Cambridge MA.

Goldschmidt, G (1991) The dialectics of sketching. *Creativity Research Journal* 4 (2) pp.123–143

Green, T.R.G. (1989) Cognitive dimensions of notations. In People and Computers V, A. Sutcliffe and L. Macaulay (Ed.) Cambridge University Press: Cambridge., pp. 443-460

Healey, P.G.T., Peters, C. R. (2007) "The Conversational Organisation of Drawing" PLT2007 International Workshop on Pen Based Learning Technologies. Catania, Italy, May 24th-25th.

Hutchins, E. (1995). *Cognition in the wild,* Cambridge, MA: MIT.

Neilson, I. and Lee, J., 1994, Conversations with graphics: implications for the design of natural language/graphics interfaces, *International Journal of Human-Computer Studies*, vol. 40, pp 509 -541.

Norman, D. (1993). *Things that make us smart*. Addison-Wesley.

Purcell, A.T. and Gero, J. (1998) "Drawings and the Design Process". Design Studies 19 (1998) 389–430.

van Sommers, P. (1984) Drawing and cognition - descriptive and experimental studies of graphic production processes. Cambridge, England, Cambridge University Press.

Scaife, M. and Rogers, Y., 1996, "External cognition: How do graphical representations work?" in International Journal of Human-Computer Studies, vol. 45, pp 185-213.

Stenning, K and Oberlander, J. (1995) A cognitive theory of graphical and linguistic reasoning: logic and implementation. Cognitive Science, vol. 19, 97-140.

Suwa and Tversky, 1996: What architects see in their sketches: implications for design tools, Conference on Human Factors in Computing Systems, Vancouver, British Columbia, Canada , pp 191 – 192.

Tversky, B. (1995). Cognitive origins of conventions. In F. T. Marchese (Ed.), Understanding images (pp. 29-53). New York: Springer-Verlag.

Xenakis, I., 1992, Formalized Music, Thought and Mathematics in Music, Pendragon Press, revised edition.