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How the computer assists composers: A survey of contemporary practise.

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Abstract

With the increased prevalence of the computer as a compositional tool comes an expansion of the musical genres that constitute “computer music.” Traditionally computer music composition was a marginal practice, dominated by a desire to use the computer to create novel music by freeing the composer from the limitations of traditional mediums. As we enter a new millennium the use of the computer for music making is common place and therefore the need to consider the impact of the computer on music composition is greater than ever. This paper will examine the ways in which the computer assists the composer and in doing so will shed light on the complex relationship between the composer and computer, and indicate trends in computer assisted compositional practice. In particular, I will suggest that the computer assists the composer in three ways, (i) by defining the range of compositional choices available, (ii) by acting as a sounding board that reflects back the composers ideas, and (iii) by being a vehicle that enables composers to realise their musical ideas.

Introduction

Computers are currently the dominant tool assisting composers in their compositional practice, and the diversity of software and hardware configurations means that the ways in which computers support the compositional process are numerous. Computer music systems, often incorporating MIDI keyboards, have almost completely replaced the piano and manuscript paper in the composition studio and computer-based recording systems now dominate recording studios. The shift to computer assisted composition (CAC) for some composers has not changed their traditional compositional practices and processes, however, for most composers the use of the computer has expanded their compositional horizons. This paper will examine the ways in which the computer assists the composer and in doing so will shed light on the complex relationship between the composer and computer, and indicate trends in computer assisted compositional practice. In particular, I will suggest that the computer assists the composer in three ways, (i) by defining the range of compositional choices available, (ii) by acting as a sounding board that reflects back the composers ideas, and (iii) by being a vehicle that enables composers to realise their musical ideas.

With the increased prevalence of the computer as a compositional tool comes an expansion of the musical genres that constitute “computer music.” Traditionally computer music composition was a marginal practice, dominated by a desire to use the computer to create novel music by freeing the composer from the limitations of traditional mediums. This experimental, or *avante garde*, attitude is consistent with the early adoption of many new music technologies, for example, the adoption of analogue electronics and tape recording which lead to the development of *Elektronische Musik* and *Musique Concrète* respectively. Early computer music making consolidated predominantly in what is called Electroacoustic music.

Computer music composition in the early part of the 21st century can no longer be so specific that it defines itself by one style. While acknowledging the historical connection between CAC and the electroacoustic music, the computer as a musical equipment needs now to be considered genre-neutral. The computer, and more specifically the processes of digitisation, has been a significant influence in the dissolution of boundaries between 20th century musical genres. In this paper I will focus on the current state of CAC and defer debate regarding the influence of the computer on the post modern condition (Lyotard, J.-F. 1984) to another forum. Therefore, in this paper, comments about CAC will take into account the rich diversity of musical genres in which the computer now plays a significant role, including electroacoustic, instrumental, choral, electronica, rock, and world music.

The findings are particularly influenced by my case study analysis during the late 1990s of five composers, namely, David Hirschfelder, Steve Reich, Brigitte Robindoré, Paul Lansky, and David Cope. The practices of these composer’s will be used as examples in this paper.

The ways in which computers assist composers will be discussed under three broad headings, increasing *choice*, *simulation* of practice, and *enabling* making. After which I will discuss some aspects of the collaborative *partnership* that develops between composers and the computer, and conclude with comments about future directions of CAC systems.

Choice

According to Mashall McLuhan (1964) the first stage of acceptance of a new technology involves it simulating previous media. This facilitates the smooth integration of the technology into existing practices. McLuhan’s observation appears to be correct in relation to the widespread acceptance of a technology, for example in activities such as writing, accounting, telephony and so on, and is a reasonable description of the use of computers in supporting established compositional processes, such as the automation of score publishing. However, it does not adequately explain the introduction of new technologies, including the computer, to *creative* activities such as composition. The creative use of technologies seems to include their mis-use as much as use.

By definition, composers (and other creative people) are looking to exploit new techniques and offer new perspectives on existing material and so, to them, technologies provide opportunities to explore new avenues of musical expression. The computer, especially in its ability to change

characteristics through re programming, assists the composer by providing a rich source of new possibilities. The compositional appetite for new software programs, new sounds and synthesis processes, and accesses to more manipulative features seems insatiable.

The computer seems most competent at meeting this demand and is able to provide choices in many aspects of the compositional process. These aspects include the nature of capturing musical ideas and material, their representation and communication, the modification and processes available for their development, and the ability to control aspects of interpretation and performance (to produce not simply invent).

Contemporary computer music systems predominantly capture musical ideas as gestures, either via MIDI or audio capture. The distinction between MIDI sequencing software and hard disk recording systems continues to blur and this reflects their underlying similarity as systems that focus on gesture capture and modification. Such systems continue the heritage of composition with recording devices begun by Pierre Schaeffer, Pierre Henry and others.

In addition to recording gestures, the computer can allow the composer to describe their musical ideas in a great variety of ways. Predominant amongst these are the use of common practice notation on a five line staff (CPN), step sequencing often using a series or matrix organisation, visual programming environments that extend the heritage of *Music N* systems and which depict musical processes as flow charts, and direct alpha-numeric linguistic descriptions most commonly using a general purpose computer programming or scripting language. This wide variety of descriptive choice is reflected in the diversity of software in this category, including *Finale* and *Sibelius* for notation, *Rebirth* and *M* for step sequencing, *MAX* and *AudioMulch* for visual description of process, and *Csound* and *jMusic* for text-based description.

While the methods of describing the music to the computer are quite varied, the processes of modification are fundamentally similar. They are similar in that the musical representation in the computer is a digital one and the transformation of captured, or described, musical source material is always conducted in this medium. However, one broad differentiation that can be made is between music as events and music as sound. Event representations (such as in MIDI messages, step sequencers, or *jMusic* scores) are more susceptible to traditional compositional treatments that focus on pitch and rhythm variations, while audio representations (as used in samplers, signal processing systems, or hard disk recorders) lend themselves most easily to timbral and time based modifications.

In the area of event structuring the computer offers the composer few “new” treatments but, because of its speed and programability, can significantly increase the efficiency of many compositional processes. For the composer this can mean faster compositional turnover, the ability to experiment with a greater number of options, or the ability to perform operations previously too difficult.

The computer is particularly influential for composition today because of its ability to handle audio data. From digital remastering of analogue orchestral recordings, to sample and synthesis

collages assembled in digital multitrack systems, to music distribution in compressed formats such as MP3, it seems that the computer's ability to manipulate digital sound is all pervasive. The most significant aspect of this for composers is the ability to produce a final audio product more than the types of manipulations that are possible. This blurring of the lines between composer and performer is well established for those in electroacoustic music circles, as is fundamental to the emergence of the computer in rock, popular, and electronica. The computer blurs traditional boundaries between writing tool and performance or presentation instrument, and in the process forces a redefinition of the term composer that includes the role as producer and distributor.

With the continuing emergence of the internet as a mode of music distribution, in particular the rise of peer to peer systems such as *Napster* and *Gnutella*, the computer assists composers in communicating with their audiences quite directly. It is inevitable that peer to peer systems will have an impact on collaborative compositional efforts as well. Paul Lansky is one composer who considers the digital distribution of music at least as important as the digital creation of the music, he writes that, "Before the advent of recording the only way one could be a sound-giver was to be a performer. Today, however, most of us would have to admit that giving and receiving sounds in one way or another is the most active part of our musical social life." (Lansky, P. 1990)

The final choice I wish to address, provided by the computer for the composer, is the option for composers to involve themselves in computer music system design and instrument creation. Such activities have long been of interest to composers, for example J. S. Bach is reported to have had quite a career in design and maintenance of pipe organs, but with computers the skills of composing and instrument making can blur quite easily. In particular this is evident for composers who compose in computer programming environments. The skills required to communicate musical ideas and to build new musical tools can be one and the same. In particular the abstracting tendency of algorithmic composition can easily lead to abstractions or structure or design that can be applied beyond the immediate situation—effectively creating a generalised tool. This blurring of activities is even more accessible to composers through visual programming environments such as *AudioMulch* and *MAX*, and is accessible to some degree in sequencing software including *Logic* and *Cubase*. Virtual synthesizer technologies such as Reason enable construction of new "patches" via virtual patch-leads to create new synthesis configurations and instruments. For some composers the opportunity to create new composition tools and instruments becomes a significant, even dominant, part of their musical life. For example, David Cope is well known more as the developer of the *Experiments in Musical Intelligence* (EMI) software that replicates musical style, than for his own compositions. This is ironic given that Cope's original motivation for *EMI* development was to assist his own compositional processes.

The computer assists the composer by providing new and expanding choices about the type and extent of music constructing activities, and by being central to many activities related to music creation into which the composer can choose to extend themselves.

Simulation

Because music is a temporal art and sound is fleetingly present, the ability of the computer to “hold” the music greatly assists the composer. Paper scores and tape recordings provide similar facilities but the particular advantage of the computer is that it can hold both score and sound, and translate between them. This ability is particularly obvious in a system which combines an MIDI sequencer with software synthesizer, where the symbolic score, held as MIDI data, can be transposed, elongated and so on, while the timbre of each event can be controlled by adjusting the synthesis parameters or waveform source material. The computer goes beyond mere storage of the music by being programmed to manipulate the stored data or to create new data, thus enabling the audition of a variety of simulations and interpretations of the piece.

Compositional technologies have long been used because of their ability to reflect or articulate the composers’ ideas. An acoustic instrument, for example, is useful for sounding out a musical theme, testing harmonic relationships, or auditioning rhythmic ideas. In so doing acoustic instruments both amplify and interpret the musician’s gestural expressions. Such feedback and amplification is a valued feature of many computer music systems which, like acoustic tools, provide real time feedback that enables an interactive and intuitive compositional process to proceed. However, feedback need not be real time to be effective. Some computer systems, particularly programmable ones, require time to compile and or render before providing feedback. Programs such as *Csound* have generally operated in this way but still provided effective compositional assistance. Audio rendering of event based scores is a translation process used by computer musicians. These processes have long been used for electroacoustic music with software such as *Csound*, *Cmix* and more recently *Supercollider* and *jMusic*.

The provision of real time audio feedback is becoming an issue these days with computer processing speeds well able to support real time audio processes. The issues for the composer now relate to quality and quantity of the feedback they desire, and the degree of manipulation they can comprehend. The cognitive load of the creative process comes into play with regard to the number and complexity of real-time adjustments a composer can usefully consider at one time.

Computer systems additionally provide visual feedback in the form of scores, waveforms, flow charts, statistics, and other representations of the music. Through audible and visual presentation of music, computers assist the composer to hear and see their work from many perspectives, to simulate ideas, and to experiment with alternate variations.

Capture and feedback are processes of communication between the composer and the computer that involve interpretation. The composer translates ideas into gestures or symbols which are stored in the computer. The storage and re-presentation of those ideas requires the computer to express them as best it can. A simple example of the limitation of the computer translation is the quantisation by MIDI systems of pitch and dynamic values into 128 steps, or the quantisation of audio systems of high frequency sounds using just a few sample values per cycle. Despite the ease of pointing to limitations, in many cases the current resolution of digital audio data is adequate and the process of translation is transparent. Another area in which the computer assists

in translation is between symbol systems, for example in the translation from MIDI gesture capture to CPN in programs such as *Sibelius* or *Finale*. In select cases, such as CPN scoring, the translation may be preferable to the inevitable inconsistency of human expression. Other examples of the interpretation being preferred include the quantisation of performed rhythms in pulse-based music, or the dynamic compression inherent in MP3 encoding which, for some, improves the presence of their music.

For humans, the role of interpretation of musical intent is highly valued, but generally in machines it is not desirable—often because the machine interpretation is insensitive. However, in electronica the characteristic interpretation of some machines has become part of style. For example the regular rhythmic subdivision and the “sound” of particular analog drum machines and synthesizers. As the computer became more a part of this community there were attempts to mimic the characteristic “sound” of particular machines through sampling or virtual analog modelling. By simulating other machines, the computer assists composers to achieve their result without recourse to the original methods or mediums. Similarly, attempts to simulate human interpretive nuance have been used in the areas of score performance, typographical design in score publishing programs, and accompaniment of live performance in well established musical styles.

Another aspect of the computer’s symbolic processing ability is that it can be applied to musical analysis and various pattern recognition tasks. Software systems, such as *CUE*, *PatchWork* and *jMusic*, include musical analysis capabilities and these and other programmable systems enable the composer to create their own analysis routines. David Cope, for example, uses the music analysis function in *CUE* to provide statistical feedback while composing (Cope, D. 1997). He finds it useful to check aspects such as the pitch class distribution, common harmonic relationships, and so on, to add to his intuitive sense of the compositional development.

Computer analysis of audio data can be used to provide information such as beat and pitch tracking or the spread of harmonic spectra. The application of these techniques is evident in programs, such as *Logic* and *Cubase*, where they use them to translate monophonic audio recordings into CPN scores, and to adjust the timing of MIDI tracks to synchronise with recordings of live performances on audio tracks. The ability of the computer to analyse music in these automated ways extends its ability as an assistant beyond the static nature of many previous music technologies. The interactive nature of the feedback through analysis takes the notion of the computer as translation device to a new level.

As with all translation, something is altered in the process, and to the extent that it saves time or improves results it is welcome, and to the extent that it distorts or inhibits clear musical expression it is unwelcome. In any case, translation is a feature of the computer in its functioning as a sounding board for the composer. The computer system as sounding board will resonate in a particular way, accentuating some aspects of what is communicated to it and dismissing others.

Enabling

In many ways the contemporary computer music systems are like modern four wheel drive recreational vehicles, most of which are owned by city dwellers who go off road on the occasional weekend. The computer music system is a vehicle with which the composer explores musical space, usually staying on the known roads and following the paths of least resistance provided by the system's design. Such usage may well indicate an effective computer music system, one that is generally efficient for creating the music it was designed to assist with, and able to move into uncharted territory when required. Most MIDI/audio sequencing/recording software fit this description for those writing music in the most popular genres. It is interesting to consider what sort of vehicle your computer music system similar to? Is it a hot rod, a bicycle, a tank, or a family-sized station wagon?

As a vehicle for exploring sonic space or musical territory, the computer music system is often expected to go "where no one has gone before" in the search for novelty and the uncovering of new methods of expression. In most cases, however, new ideas come from the composer and the computer assists as an enabler of those ideas rather than encouraging them. In this relationship the importance of clear communication between composer and computer, as discussed above, is critical. The effectiveness of the computer system from this perspective lies in its ability to help realise the compositional intentions of the composer. This is made additionally awkward because those intentions are rarely clear in the mind of the composer, usually evolving and clarifying as the compositional processes proceeds. The computer music system can act as an enabling device bridging the gap between conception and realisation as sound or score.

In helping realise the composition, the computer system typically works in the symbolic domain, audio domain, or both. Exploration of the sonic space has dominated computer music activity because of the computer's particular ability to work with sound through sampling and synthesis. This ability has allowed the computer to imitate other sounding devices—including acoustic instruments, the human voice, and sounds of other machines—as McLuhan's theories predict, as well as to create new sounds and textures. Significant work in the computer music community has resulted in the development of synthesis and signal processing techniques that have opened up vast new vistas of sonic territory for exploration. The balance of imitative and innovative audio treatments in computer assisted composition is particularly evident in modern film scores which typically include music in a range of genres, much of which is produced with the one computer system. For example, David Hirschfelder's film scores often include orchestral works which combine sampled sounds and live recordings, as well as sections of synthetic sound scapes, and a popular song that typically consists of live vocals and guitar over a computer generated backing. All of these are created in the one CAC environment.

In the symbolic domain, the computer system generally provides a temporal canvas upon which the composer arranges the musical symbols into a structure, CPN scoring software typically works in this way. For the composer, the metaphorical similarity makes the transition from paper score to computer screen quite easy. The "arranging" pages on many sequencing programs provide a similar canvas metaphor on which the composer manually organises the musical objects. Other computer music systems, not surprisingly those that require some programming

expertise, go beyond manual editing to enable automated symbolic manipulation. Programs such as *Open Music*, *Common Music*, *AC Toolbox*, *MAX*, and *jMusic* provide composer-definable symbolic manipulations at the musical-event level. By using this capacity composers are able to implement known or invented theories and techniques. These can be as simple as a cannon or thematic phasing, and as complex as the Generative Theory of Tonal Music (Lerdahl, F. and Jackendoff, R. 1983) or the sonification of mathematical models of physical systems (Monro, G. and Pressing, J. 1998). The use of the computer to enable the implementation of theoretical concepts was seen in the earliest computer music (Hiller, L. A. and Isaacson, L. M. 1959) and is particularly evident in the music of Iannis Xankis who used the computer to realise many formalised processes, in particular various probabilistic functions (Serra, M.-H. 1993). It can also be seen in the use of Cellular Automata processes for pitch and rhythms in the software *CAMUS 3D* (McAlpine, K., Mirando, E. and Hoggar, S. 1999), and for timbral changes through filtering (Kreger, T. 1999).

As well as enabling the creation and production of music, the computer can assist the composer in its distribution. The burning of music onto CDs and the compression of audio for internet distribution as *MP3* files, or as streamed formats including *RealAudio* and *ShockWave/Flash*, has become common place. With distribution assistance on hand the composer is able to use the computer at all stages of the music making process, from conception to audience delivery.

The computer music system is able to assist the composer at all stages of the music making journey. At each stage the computer assists to the degree that it enables composers to realise their intentions, to explore pathways, and to help reveal new sonic possibilities. It assists in capturing and solidifying those ideas and sounds into a completed musical form.

Partnership

For the most part this paper has proceeded as a homage to the abilities of the computer music system to assist the composer. My main objective has been to survey the ways in which contemporary computer music systems act to assist the composer, and I have written elsewhere about the significance of the composer in realising this potential assistance through engagement with the compositional process. (Brown, A. 2000) However, it should be emphasised that creating with technologies is a partnership and the degree to which the computer can assist the composer depends upon the fit between the two.

The musical thinking of the composer needs to align with the design and working methods of the system for there to be an effective partnership. Given that a computer music system generally reflects the values of its designers, alignment between system and composer usually occurs when designers and composers share similar musical cultures and values.

Computer music systems tend to solidify the musical preferences of their time, either for particular music structures, processes, sounds, or other elements of style and aesthetic. This means that composers of a certain age tend to use tools created around the time their musical preferences were forming, and once they are familiar with those tools their partnership tends to

persist. Computer music systems, while evolving (some dramatically) do have a finite life span that is most closely related to the pace of cultural change but is also at the mercy of technological changes and fashions. For example, new music systems today are more likely to be written in *C++* or *Java* than *LISP* or *Objective C*. This is not because of the languages inability to express musical ideas but as a result of which languages are currently popularity and widely supported.

Computer music systems also tend to focus on a particular genre of music and the specific requirements of that style. While this trend is quite apparent in software it also effects hardware. For example, the use of MIDI keyboards as input devices was once dominant, but a growing number of composers writing electronica prefer to enter music in a matrix-like display than to perform it on a keyboard.

In using computer music systems to automate and make efficient our compositional procedures we are, in the language of Bruno Latour (Latour, B. 1995), *delegating* responsibility for a portion of our work. Computer assisted composition is not simply human-directed composition because the computer does play a role—by assisting it has an influence. However, the more responsibility we pass to the computer music system the greater the expectations on the composer using the system. This might seem conter-intuitive but put more simply, greater emphasis on the unintelligent (even perhaps unskilled) computer requires more of the (presumably) intelligent composer. A misunderstanding of this position is at the root of Microsoft's disempowering useability policy, which assumes that the more responsibility delegated to "wizards" the "easier" the system is to use. On the contrary, the result is a more limited the system and a demand for more ingenuity from users to recover from errors and to get their non-conformist work done. (Microsoft achieves its intention, to make users increasingly dependent on Microsoft software). In Latour's terms, as the computer assumes responsibility for tasks, in its necessarily automated way, the more it relies upon a particular behavioural pattern in order to act correctly—it increasingly *prescribes* what the user must do. The issue of delegation in creative tasks is even more critical than in office work due to the deliberately novel and unexpected implications of creative processes.

The efficiency gained by enshrining practices within computer music systems is the same force that prevents the system from assisting the composer to move beyond those practices. This "two edged sword" of technology is well understood but is, nevertheless, a significant issue in considering the ways the computer assists composition. A system feature that is considered a positive assistance by one composer may well be considered a hindrance by another. For example, the normal process in a MIDI sequencer or music publishing program for all tracks, or parts, to playback at the same tempo is coherent with traditional ensemble performance practice and generally considered a positive feature. However for Steve Reich, who likes to write music with parts running at differing speeds (phasing), such a characteristic would most likely be a frustration. More importantly, for a composer working with that system, the rigidity of that feature may mean they never consider the possibility of music that phases—surely a pity. Computer music systems do assist composers, but they also direct them.

Conclusion

As the computer becomes increasingly pervasive in our community, the impact of computer assisted composition effects a broader range of musicians and musical genres. No longer is *computer music* limited to electroacoustic musicians, however, the knowledge of and experience with computer assisted composition within the electroacoustic music community is a valuable resource that can be shared.

A broad definition of the computer assisted composer is called for as more and more music making activities are centred around the digital medium. The computer musician can now be composer, performer, producer, instrument maker, and distributor. The traditionally solitary working patterns of the composer may continue, but with an expanded definition of a computer musician comes an increasingly collaborative community in which the “composer” interacts with other artists and the audience through the computer. In particular the expansion of peer-to-peer networking will mean that the computer will provide the composer with even greater collaborative and communicative opportunities.

The computer, as a digital device, brings its own idiosyncrasies to the compositional partnership. In particular the representational quantisation and the interoperability of various input/output forms play a role in the computer’s musical interpretation and musical representation. The exploitation of the computer in more and more musical genres demonstrates the increasing acceptance of and reliance upon it as musical tool and instrument. Electroacoustic musicians, exploit the digitalness, for example, through granular synthesis, while electronica artists value quantised timing and synthetic timbres, and rock musicians make use of digital processing treatments on instrumental and vocal sounds.

The partnership between computer and composer works best when they share similar musical values. The computer system inherits values from its designers and the context within which it was developed (time, place, and musical culture). The composer chooses systems whose features resonate with their requirements and preferences, and the extent to which this partnership persists depends upon the degree to which each evolves at a similar pace. Computer music systems rely on both their designers and users to evolve new processes and refine others, some times the composer is very reliant on the system designers and other times they can make changes themselves. Composers therefor relate to the system designers as well as to the system.

The partnership involves a delegation of tasks and responsibilities from the composer to the computer music system. In the process the computer is able to assist the composer, but also to direct them. The delegation often leads to the establishment of habitual patterns of usage that result in characteristic features in the music composed. The computer assists the composer by increasing or directing the compositional choices, but simulating the musical process and possibilities, and by enabling the realisation and communication of compositional ideas and the distribution of resulting outcomes.

The computer has become an invaluable assistant for the composer, one that provides support and direction at each stage of the musical journey from idea, through development and realisation, to

distribution. The challenge for the composer is to take advantage of the assistance provided while remaining wary of the overly habitual. Consideration of computer assisted composition as a partnering, rather than as a governing, is a positive way of understanding the musical assistance provided by the computer.

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