VIEW: VISUALLY INVESTIGATING ELECTROACOUSTIC WAVES

Anna-Marie Higgins and Inmaculada Arnedillo Sanchez
CRITE, Centre for Research in I.T. in Education, Trinity College Dublin
Dublin 2, Ireland
amhiggins@clubi.ie - Macu.Arnedillo@cs.tcd.ie

Abstract

Music composition is an onerous task. The composer must know how to deal with the elements of music and then convey his ideas via a performer to the listener. However, by constructing a piece of electroacoustic music at the computer, novice composers can avoid some of the obstacles that hinder the delivery of musical ideas and in doing so, gain hands-on knowledge of two of the most important elements of music in general - sound and structure. The findings of this study suggest how some improvements to the graphical interface of an audio editor could make this a more achievable learning goal.

1. INTRODUCTION

1.1 What composers need to know

In the past, a knowledge of nine musical elements – pitch, duration, pulse, texture, dynamics, tempo, style, structure and timbre – has been deemed essential for a composer to work creatively with sound. Much training is required for proficiency in these areas to be attained. Furthermore, these musical constituents have, for centuries, been inextricably linked with the technical skill needed to capture the music on paper.

This paper is divided into five sections. The introduction outlines key concepts in music composition, highlighting the need to visually represent the contents of musical pieces. Setting out the aims of the paper, it introduces electroacoustic music, whose principles tie in with the context of the present study. Section two describes how the ideas were put into practice. The results of the study are summarised in the third section and these are discussed in section four, with some concluding suggestions.

1.1.1 ***Musical notation***

The invention of the musical stave, one thousand years ago, has allowed complicated musical ideas to be composed, analysed and performed.

Figure 1 is an extract from a piano score and displays melody, tonality, rhythm and beat; it indicates the speed and volume at which the music is to be played and it outlines the tone colour or timbre of the music required by the composer, who has allocated the music to a specific instrument.

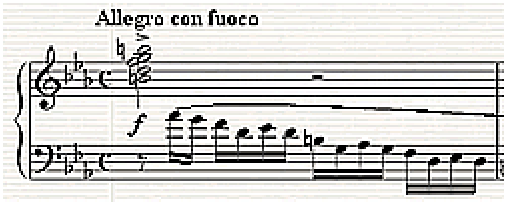

Figure 1 Piano score illustrating many musical components

Perusal of the entire score also allows an insight into how the piece has been structured. This facilitates a better understanding of the work, for those who can read music.

Such graphical representation is also an important tool for the composers themselves. Just as a mathematician needs paper to work out long calculations, a composer benefits from the visual recording of the work in progress.

1.1.2 ***Graphic notation***

Some contemporary composers use graphic scores to illustrate their music in diagrams or drawings. They explore the potential of sound and then use clear symbols to match their ideas. There are problems with interpretation as there are no hard and fast rules governing the symbols. Figure 2 shows repeated shapes depicting indeterminate instructions for singers.

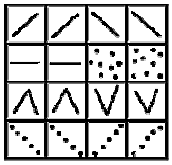

Figure 2 Graphic score illustrating experimental music for voices

Either form of notation can be an obstacle to creative music composition, one because it is laden with detail, the other because its symbols are not universal and may not be deciphered accurately.

1.2 Electroacoustic music

Manning [1] points out that the opportunities to work with sound within the electroacoustic medium have no precise parallels to conventional music making. As the sound-producing agents have changed, so too must our approach. To tap into the creativity of some young students, the authors choose electroacoustic music as the composing genre.

This sonic art form explores the interaction of natural and electronically generated sounds and effects. It is manageable for novice composers because it makes possible the conception, production, presentation, storage and cognition of works without their requiring knowledge of every component of conventional music as outlined in the previous section.

1.2.1 Sound and structure

Paynter [2] defines the unique skill of the composer as being able to judge precisely when things should happen in the timescale. As sound design moves increasingly towards micro-level control, Truax [3] observes that sound and structure have become increasingly inseparable. Stockhausen [4] supports the view that form and material are one and the same and calls this the most important fact to come out of the twentieth century.

It is worthwhile, therefore, to isolate these two elements – material (sound) and form (structure) – and to learn the process of composing by using them, predominantly, in the construction of a work.

1.3 Digital audio editor

A digital audio editor acts as a platform for transforming and organising sound. It has tools and effects that permit the user to visually add precise changes in the audio over time. Figure 3 illustrates one of the simplest of these. The waveform on the left (A) has done an about-turn of 180 degrees, clearly depicting how the sound has been reversed (B).

Figure 3 Reversing a sound

The software also allows the structure of a piece to be graphically represented, so that it is possible to cut, copy, paste, delete and trim sounds and to insert these in the desired location. Figure 4 demonstrates how a waveform (A) can be modified by inserting silence and by copying and pasting part of the sound into a new position, changing the timescale of the events within the piece (C).

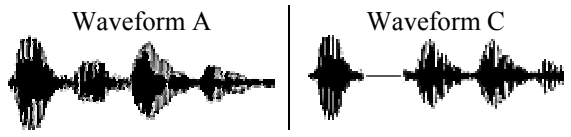

Figure 4 Restructuring a waveform

The authors feel that by manipulating pre-recorded sounds in a digital audio editor and by re-organising them into a new work, inexperienced composers could express otherwise-dormant musical ideas.

A case study allows close observation of this process. Problems encountered by the composers, together with an examination of their works point to the need for clearer graphical representation in the chosen software.

2. DESCRIPTION AND METHOD

2.1 Saturday morning fever

Seven students, supported by two adult mentors and a teacher, test the hypothesis outlined earlier. The research takes place within the context of an informal learning experience: a Computer Clubhouse run by CRITE. The students are fifteen and sixteen years of age. None of them has composed before and none can read standard musical notation. They participate in the study for two hours each Saturday morning over a period of six weeks. Each student is assigned a Windows-operated computer and the group is taught how to use the basic functions of a digital audio editor, in this case *Sound Forge*.

2.2 The task

The participants are asked to compose a piece of electroacoustic music that appeals to them. It should use contrasting ideas, should have a climax and should last sixty seconds.

2.2.1 Visually working with sound

Having ripped a track from their own CD, the participants examine it, in wav format, in the audio editor. They engage both visually and aurally with sound. The visual aspect of the software makes the contrasting motives easier to find. In Figure 5, a sustained note on the clarinet causes the first shape while the spikier figure is produced by a ten-note rhythmical motif.

Figure 5 Waveform illustrating contrasting motives

Adding delay effects, bending the pitch, filtering frequencies and stretching time can transform a sound. Sometimes the waveform is physically changed and it is possible to compare it with the original. Figure 6 shows the effect of a sweeping phaser on a waveform.

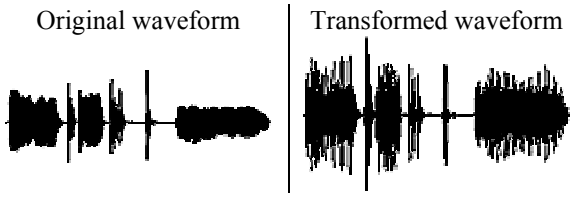

Figure 6 Some transformations are visually evident

2.2.2 Visually working with structure

Initially, the act of moving parts of the waveform

around is a straightforward process, as demonstrated already in Figure 4. As more ideas are superimposed, it becomes more difficult to keep a track of events.

2.3 Methodology

During the early sessions the teacher demonstrates how to compose a piece from sampled sounds. The students are reminded each week of the objective – to find and transform two contrasting sound samples and to mould these into a work that they like, lasting one minute. Informal conversations with the participants, the students' weekly descriptions of their work in progress and their completed questionnaires contribute to the store of qualitative data gathered during the project. Statistical results are gleaned from a basic analysis of the compositions themselves, with accompanying reflections made by the teacher and mentors.

3. RESULTS

3.1 General comment

The sampled sounds came from a wide range of sources - rock and pop music (by Thin Lizzy and Westlife), folk-based pieces (*Riverdance*), film music (*Close Encounters*) and Baroque music (by Vivaldi). Despite the diversity of the sound material, there are some findings that pertain to the group as a whole. These show that the participants' control of the sound and their ability to structure the work are heavily influenced by what they see on the screen.

3.2 The interface and sound manipulation

The students favoured transformations that visibly altered the waveform and tended to shun those that had no visual impact. Consequently, many of the pieces have a fade-in or a fade-out, for example.

Similarly, the students recognised that in a stereo waveform, there are two independent channels. Some of them grasped the opportunity to pan the sound from left to right speaker, an action that was immediately reflected in the waveform as can be seen in Figure 7.

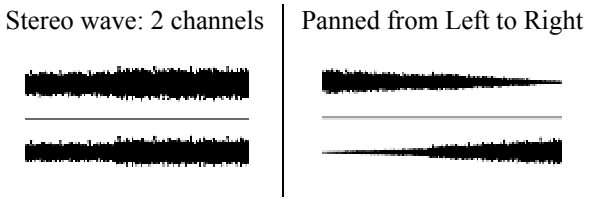

Figure 7 Panning a sound from left to right speaker

Applying a filter to a sound can also modify the wave considerably if it removes all but a few of the frequencies that are present. This transformation is used to good effect in one of the compositions. Time stretching was also a popular device, probably because it not only lengthened the duration of the sound but also the physical length of the wave on the screen.

Remarkably, few if any of the compositions featured delay effects such as reverberation, despite their prevalence in day-to-day music. When they tested the echo, for example, they tended to undo it quickly, perhaps because it did not make a noticeable visual difference to the wave.

It is fair to point out that the least successful electroacoustic compositions, from the point of view of sound manipulation, were those that attempted to use too many sounds and those that did not remove the strong beat. The audio editor cannot be blamed for either of these flaws.

3.3 The interface and structure

In order for a listener to notice how events relate to each other in a piece of music, the composer must set up these relationships in the first place, then express them clearly through repetition and variation. The students found this aspect difficult and were reactive rather than proactive in structuring their pieces.

Sound Forge does not have a multitrack facility, which would have allowed them to physically place different happenings on different tracks before mixing them down into a single wave. This hindered the students considerably. They were obliged to paste events directly onto the main waveform. When several events were taking place simultaneously, it became impossible to extricate any element that was no longer desired. Since the composing period took place over a period of six weeks, the students were unable to say exactly what they had added to the mix during earlier sessions.

The interface invited basic edits such as cutting, pasting and the insertion of silence, as displayed in Figure 8. Here the left and right channels are notably different from each other as the student deliberately cut parts of the wave out of each track. The aural result is uneven.

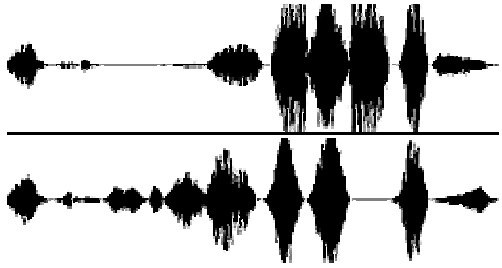

Figure 8 Finished work displaying crude editing

The request for a climax did not produce a significant focal point in six of the seven works. Many associated the notion with volume and felt, perhaps, that making the wave "fatter" towards the end might suffice. Again, they seemed to rely more on their eyes than their ears to gauge this feature.

In order to judge how best the composers responded to the main task, it is worthwhile to record this information statistically.

3.4 Analysis of the compositions

The works (numbered one to seven) are analysed in Table 1. Four criteria are assessed here – the duration of the piece, the effective transformation of sound to remove traces of their origins, the musical structuring of the piece and the existence of a climax in the music.

For the categories dealing with sound and structure, the works are given a rating from one to five as follows:
5 – Original, very effective or musically handled
4 – Effective most of the time
3 – Has some importance in the piece
2 – Not an integral part of the piece
1 – Barely noticeable or not present in the piece

These are universally accepted descriptors for making judgments about certain qualities in a work.

Piece	Length	Sound 1 - 5	Structure 1 - 5	Climax
1.	63”	4	4	Yes
2.	65”	5	3	No
3.	88”	3	1	No
4.	75”	3	1	No
5.	51”	3	1	No
6.	52”	1	2	No
7.	71”	1	1	No

Table 1 Analysis of the seven compositions

It is apparent that while their ability to manipulate sound shows no cause for concern, for the majority of the composers, the big stumbling block is the structuring of the piece. Can this weakness be rectified?

Finally, the teacher asked the composers to find descriptive titles for their works. These became *Morning, Hallucination, Twilight Walking, Jarred, Buskers, Alien Biker* and *Clash of the Titles.*

4. DISCUSSION AND CONCLUSIONS

4.1 Aims revisited

On the basis of the evidence gathered during this project it is possible to make some general observations about the usefulness of electroacoustic composition as an initial stepping stone for novice composers and of the visual impact of a digital audio editor on this process.

4.2 Musical outcomes

The participants discovered several higher-level principles of music that are applicable to all genres. These were associated mainly with tone colour, volume and direction of the sound. The waveform gave an indication of the length of the piece, the relative loudness of sections and the occurrence of events. The simple interface focused the users’ attention and allowed them to closely monitor the results as they processed the sounds.

Despite the authors’ misgivings about the meandering nature of some of the pieces, it is true to say that all of them had valid start and end sections. The composers liked their own work and since this was part of the task definition, it may be concluded that the students fulfilled the brief they were set.

4.3 Suggested improvements

Evidence cited earlier shows that some adjustments in the teaching strategy would encourage a more musical outcome. These include the strict limiting of the number of sound sources being used and a longer examination of works from the electroacoustic repertoire.

4.3.1 ***Deciphering the content of a wave***

The composing experience did *not* give them a deep understanding of structure. Arising out of the study, it was obvious that they found it difficult to recognise the temporal relationships between events. The inexact nature of the editing environment led to frustrated attempts at removing certain effects. By the final session, the waveform contained much sonic detail and many of the students passively accepted sound events that they had not planned for the piece. There are seven different musical motives embedded in the waveform in Figure 9, yet it gives the onlooker little or no idea of their nature.

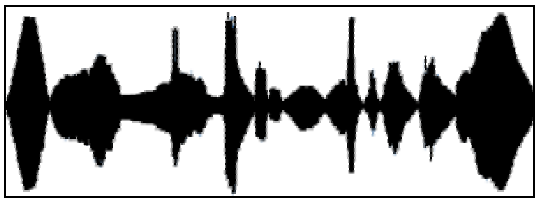

Figure 9 Typical waveform lasting 60”

Audio editors with multitrack capability already exist and show when each musical event occurs in a piece. However, when many strands of music are intertwined it is difficult to interpret exactly the meaning of each wave on the screen.

The authors propose a more graphically oriented screen that would enable the composer to keep track of the musical content of their pieces. They suggest that such a screen would permit the composer to visualise aspects other than the amplitude of these musical figures, be they long sustained notes, short spiky tunes or complicated rhythms.

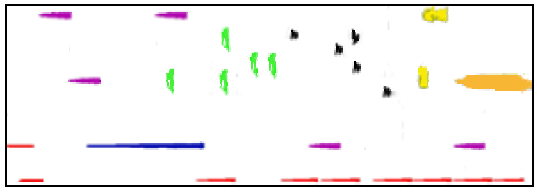

Figure 10 The seven motives that produced the waveform in Figure 9

Figure 10 gives a general idea of how such events could be displayed by using different colours and shapes to differentiate between them. Furthermore, with such a screen, a composer could move, remove or duplicate any of the events non-destructively, regardless of the polyphonic texture of the music. The authors recommend that each event could be placed on a separate layer, as in image-editing programs. An explanatory legend or key could divulge information about the individual shapes

such as pitch, rhythm, denseness of the sound and its volume. In present-day multitrack programs, the final version of the music is mixed down into one waveform, for continued editing. The authors advocate the retention, within this mix, of the colours associated with each sound event to render possible a more easily interpreted overview.

4.3.2 Making melodic outlines clearer

It is impossible to work out the tune from a sound wave. Who could guess that in Figure 11, the same clarinet note produced the first and fourth shapes? Similarly, the third and seventh shapes were caused by the note A above middle C while the sixth and ninth shape came from the note E? From the squiggles on the screen, one can simply deduce that some of the sounds are louder than others and that they occur at a similar distance from each other.

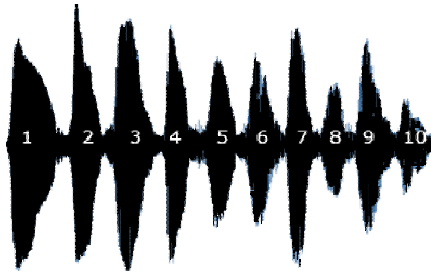

Figure 11 Waveform depicting a ten-note motif

For the listener, the direction and shape of a melody contribute greatly to the mood of a piece. Ascending scale passages are associated with joy. Melodies that crawl slowly downwards indicate gloom. The melodic extract shown in Figure 12 is quirky. It flits about in a rather directionless manner. Within the space of ten notes, there are six leaps in close proximity, giving the phrase a humorous appeal.

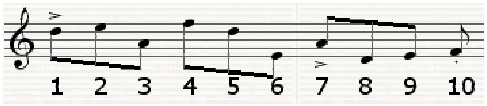

Figure 12 The ten-note motif on the stave

While it is not possible to replicate this motif in an audio editor as precisely as on a musical stave, the authors put forward the view that it would be helpful to a composer to see the outline of each tune they write, perhaps in the shape of a red line as in Figure 13.

Figure 13 Melodic outline of the ten-note motif

4.4 Summary

This paper argues that with more visual support, the act of composing music may be tackled and mastered at a deeper level than at present.

In confronting the difficulties arising from using notation and an intermediary – the performer – to interpret the wishes of a composer, the authors turned to electroacoustic composition, which removes the onus of scripting the music from the composer, who can now record and perform his ideas himself by using a digital audio editor.

The study specifically explores electroacoustic composition for several reasons. It removes obstacles that hinder other types of composition as it does not require a mastery of complicated elements such as tonality and harmony. It lends itself to achieving expertise in the areas of sound and structure, two of the cornerstones of composition.

In order to achieve the stated aims of encouraging creative work, this study highlights the importance of the visual aspect of the software. It points to the ease with which composers could work on multi-layered sounds if the aural contents of each layer could be made salient by means of colours, for example. This would facilitate the positioning and re-positioning of events within the overall framework with greater ease.

The study provides evidence that when novice composers are working on a piece over several weeks, they lose some of their musical motives within the texture. The authors propose that an audio editor that could generate a line in the shape of each tune would help to solve the problem.

Most music students have little intuitive or encultured knowledge that they can bring to bear on the process of composing electroacoustic music. However, this study shows that by attempting it, they can learn skills that will foster enquiry into composing in general.

References

[1] Manning, P. "Ownership and control of the creative process in the composition and performance of electroacoustic music." URL: *http://mitpress2.mit.edu/-e-journals/LEA/ARTICLES/manning.html*, 1999

[2] Paynter, J. *Sound and Structure,* Cambridge University Press, Cambridge, 1992.

[3] Truax, B. "Electroacoustic music and the Soundscape: the Inner and Outer World." In J. Paynter, T. Howell, R. Orton, & P. Seymour (Eds.), *Companion to Contemporary Musical Thought, Vol.1,* Routledge, London, New York, 1992, pp. 374–397.

[4] Stockhausen, K. *Stockhausen on Music: Lectures and Interviews.* Maconie, R. (Ed.) London, New York: Marion Boyars, 1989.