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'TOY SYMPHONY': AN INTERNATIONAL MUSIC TECHNOLOGY PROJECT FOR CHILDREN

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SUMMARY

The Hyperinstruments research group at the MIT Media Lab in Cambridge, Massachusetts, USA. developed a number of technology-based instruments and a piece of graphical software for composition for children in the 8-12 year age range. The 'Toy Symphony' project gave children in various cities in Europe and the USA access to these technologies during a series of workshops and culminated in a public concert in each city involving children, a local professional orchestra, conductor and violin soloist. The technologies, the workshop process and the concert are described and some observations are made on the value of these technologies for music teaching and learning.

It is generally accepted that people interact with music through one of three modalities – by performing, composing or listening. Developments in technology aimed at generating a more interactive experience for the user have tended to focus on the performing and composing aspects[1]. Technological innovation in the area of performing has typically emphasised the creation or adaptation of interfaces or instruments designed to allow the user to control music in real-time. One approach consists of the enhancement or alteration of standard instruments by the addition sensors of various types, the data from which is used to control synthesizers or moderate the acoustic output from the instrument[2]. The complimentary approach consists of the design of non-standard physical interfaces, which may then act as controllers for synthesizers[3]. However, there have been very few meaningful attempts to translate these approaches into an educational setting or provide musical experiences for the novice musician.

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1 While mindful of the "active construction" view of meaningful listening, in the context of this paper, CDs and other 'music listening' devices would fall into the category of 'passive' technologies.

2 For example, Paradiso J and Gershenfeld N, (1997). Musical Applications of Electric Field Sensing, *Computer Music Journal*, 21,(2), MIT, Cambridge Mass.

3 Some examples of this approach are:
The Hands. Michel Waisvisz, http://www.xs4all.nl/~mwais/
Sensorband, http://www.sensorband.com/
Weinberg G, (2002). Playpens, Fireflies and Squeezables. New Musical Instruments for Bridging the Joyful and the Thoughtful. *Leonardo Music Journal*,12.

On the composing side, a wide variety of software packages exist which are designed to allow the user to create store and edit musical compositions. MIDI sequencers such as Logic and CuBase and notation packages such as Finale and Sibelius are powerful tools for music composition. Software aimed at enabling children to compose, such as Morton Subotnics 'Making Music'[4] are also in common currency. However, in many cases these tools are either designed for the professional user and so are too complex and unwieldy for the novice, or are too simplistic in their range and depth to allow for the sort of powerful musical experience which we might wish children to have.

'Toy Symphony' is a project which attempts to tackle these issues by the development of a number of physical interfaces for music performance and a piece of composing software specifically tailored to the needs of children. The project culminates with a series of concerts involving the children, professional orchestras and soloists performing together using a combination of traditional and technology-based resources. This paper gives an overview of the project, describes the technologies used and their deployment in workshops with children and offers some observations on the potential offered by these technologies for music teaching and learning.

'TOY SYMPHONY'

The 'Toy Symphony' project originated in Professor Tod Machovers[5] 'Hyperinstruments' research group at the MIT Media Lab in Cambridge, Massachusetts, USA. This is a research group which has specialized in the design and development of physical interfaces for music performance, both for professional musicians and novice users. Over a period of two years the group developed a number of physical instruments or 'Music Toys' for children in the 8- to 12-year age range, two of which (called 'Beat Bugs' and 'Music Shapers') were used during the course of the project. A piece of graphical software for composition ('Hyperscore') was also developed. Over the course of the project, workshops were held in a number of locations in Europe and the USA including Berlin, Dublin, Glasgow, Boston and New York. During the workshops some children learned to perform using the 'toys' while other children composed using the Hyperscore software. Each workshop series culminated in a public concert involving children, a local professional orchestra and conductor with violin soloist. Orchestras participating in the project included the Deutsche Symphony Orchestra, conductor Kent Nagano, The Irish National Symphony Orchestra and The BBC Scottish Symphony Orchestra, both conducted by Gerhard Markson and the Boston Modern Orchestra Project, conducted by Gil Rose. The workshop process and concerts will be described in more detail below, but first a more detailed description of the music toys.

[4] http://www.creatingmusic.com/
[5] http://web.media.mit.edu/~tod/

MUSIC TOYS

'BEAT BUGS'

Two physical interfaces were used in the course of the project. These were called 'Beat Bugs' and 'Music Shapers'. The first of these is a hand-held percussion instrument, approximately the size and shape of an Easter egg (see Figure 1).

FIGURE 1. Beat Bugs

Designed by Gil Weinberg and Roberto Aimi at the MIT Media Lab, 'Beat Bugs' are designed to be played in groups of eight. Each Bug is connected via a cable to the same Macintosh computer and a series of amplifiers and mixers. The 'Bug' is held in one hand and struck or tapped with the other, sending a signal to the computer to produce a percussion sound. Each 'Bug' produces its own, distinctive timbre and contains its own speaker, so the players can hear the sounds they produce. It also contains LEDs (light-emitting diodes) which flash when it is struck, providing additional visual feedback to the player and audience. The bug is velocity sensitive, providing for dynamic range and expression[6].

In its simplest 'Free-Play' mode, the 'Bug' acts as a standard electronic drum. However there are several 'modes' in which the group of 'Bugs' may be configured which offer the user a much richer and more interesting experience. In 'Drum Circle' mode, the 'Bugs' are configured to 'remember' short rhythmic patters tapped by the user. The length of these patterns may be varied from one to eight measures. The user taps in a rhythmic pattern of an appropriate length and the 'Beat Bug' then plays back the pattern in a continuous loop. The user may then vary aspects of this pattern in real time by bending the two 'antennae' at the front of the 'Bug'. Each antenna performs a different function. One causes changes in aspects of either pitch or timbre. For example, bending this antenna down and back may cause the pitch to rise and fall without affecting the rhythmic pattern itself. The other antenna controls subtle variations in the rhythmic pattern itself. Bending this antenna causes groups of 'sub-beat' embellishments to be added to the pattern between the notes of the pattern itself. The more bend that is applied, the more notes are added.

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[6] A full technical description of the Beat bug System is contained in; Gil Weinberg, Roberto Aimi, Kevin Jennings,(2002). The Beatbug Network – A Rhythmic System for Interdependent Group Collaboration. *Proceedings of the 2002 Conference on New Interfaces for Musical Expression (NIME 02),* Dublin, Ireland, May 24-26, (2002).

In ‘Snake’ mode, which is the mode that is used for concert performance, the emphasis is on exploring the networked interdependency of the ‘Bugs’ to allow users to share and manipulate each others rhythmic motives. The leader makes a short rhythmic motif, which is then sent to another member of the group. That player then has the option to embellish and manipulate this pattern before sending it on to another player. After a number of cycles where different players experiment with this pattern, it becomes fixed in a particular bug and the holder of that ‘Bug’ can make a new pattern which is sent into the group to be traded and embellished. This process continues until each player has a fixed pattern. Throughout this process, the travelling pattern (the ‘head of the snake’) is heard louder then the stationary patterns.

When each player has a stationary pattern, a series of co-ordinated group actions may take place. For example, if all players strike their ‘Bug’ simultaneously, all but two bugs will stop playing and those two players may now perform a short duet. After a number of short duet and quartet sections, all players improvise freely until the piece reaches its climax.

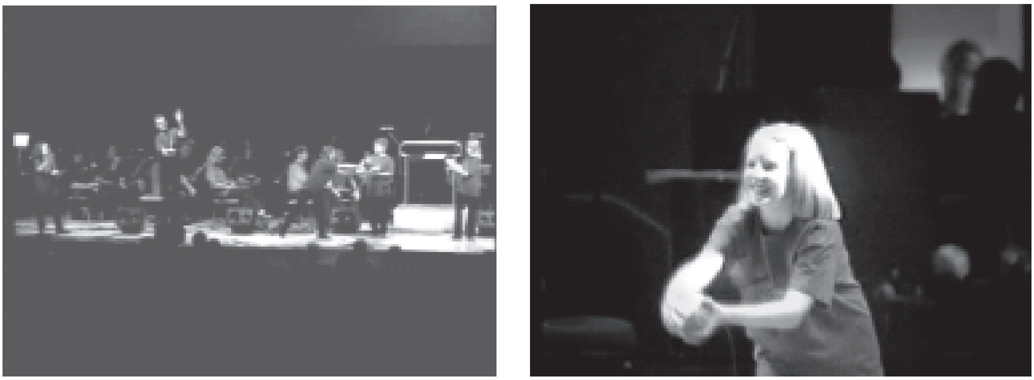

FIGURE 2. Glasgow primary school children in concert with members of the BBC Scottish Symphony, February 2002.

The ‘Beat Bug’ setup, as implemented during the project, represents a sharing of control between the children as performers and the system designers. Most aspects of the system are customizable, depending on the needs and abilities of a particular group of children. As they enter their rhythmic patterns against a background pulse the children may get slightly off the beat, in which case the system can ‘quantize’ or fix small rhythmic errors, but the degree to which this is done is entirely flexible, so as the children grow in confidence, they may take more responsibility for the musical output. Similarly, while the system provides a structure within which the children play, the actual rhythmic content of the piece is flexible. The children may either improvise their own patterns or use pre-composed rhythmic motives.

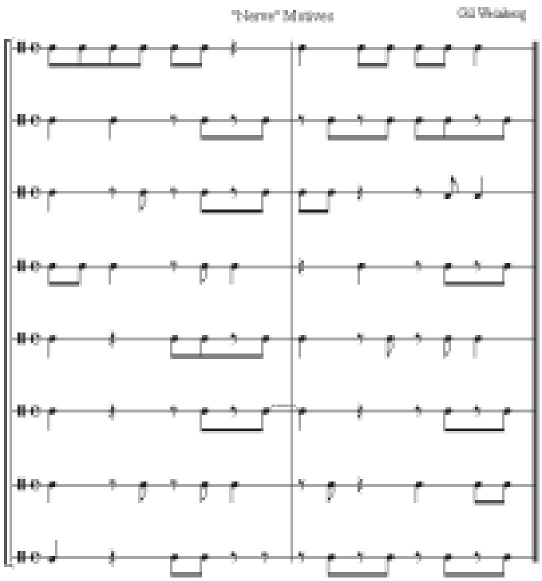

FIGURE 3. Rhythmic Motives for 'Nerve'

In concert, children in each of the five locations performed a piece called 'Nerve' composed by the system designer Gil Weinberg, based on his set of eight, two-measure rhythmic motives (see Figure 3)[7]. Each concert performance involved six children and two members of the participating orchestra. In all concerts, children performed the piece successfully, executing their rhythmic motives, entries and exits, improvisations and duet sections with considerable skill and enthusiasm.

'MUSIC SHAPERS'

The second physical interface used during the Toy Symphony project is called the 'Music Shaper'. 'Music Shapers' are soft fabric and foam balls, which are played by squeezing (Figure 4).

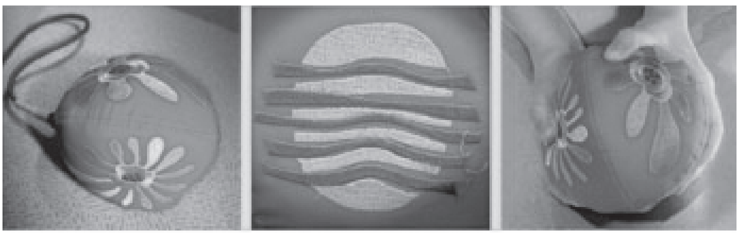

FIGURE 4. Music Shapers

Each 'Shaper' contains a set of pressure sensors, which measure squeezing pressure along two axes. The data output by these sensors is fed to a computer where it is processed and may be used in a number of ways. 'Shapers' may be used to manipulate in real-time the

7 Video footage of children playing 'Beat Bugs' in concert along with further information about the project may be found at http://www.toysymphony.net

output from conventional instruments, or to trigger and manipulate pre-recorded samples or synthesized sounds.

During the course of the project, 'Music Shapers' were used in the performance of two pieces. The first of these, called 'Nature Suite' was written by French composer Jean Pascal Bientus. Written for string orchestra and four Shaper players, the piece consists of four short movements based on the seasons – Spring, Summer, Autumn and Winter. In this piece, the Shapers are used in a variety of ways. In the Autumn movement, they control atmospheric ambient sounds such as wind and rain, while in other movements they trigger or control single pitches or short MIDI based melodic fragments. The piece is written in the manner of a concerto, with the focus shifting from orchestra to shapers and back. Nature Suite was performed at the three concerts (Berlin, Dublin, Glasgow) which comprised the European leg of the Toy Symphony tour (Figure 5).

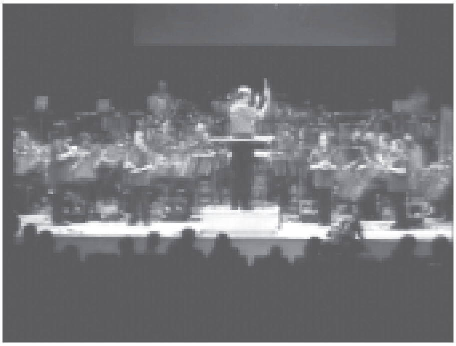

FIGURE 5. BBC Scottish Symphony, conductor Gerhard Markson and four children playing 'Shapers' in concert.

For the American concerts, a second 'Music Shaper' piece was added to the program. While 'Nature Suite' is written in an accessible, tonal style, the piece which was added could not be more different, both in style and in the way in which the Shapers are used in the piece. This piece is called 'Gestures'. It was written collaboratively by Natasha Sinha, a 12-year-old Boston composer, and Hugo Solis, a member of the Hyperinstruments research group. The piece was written for six professional musicians (two trumpets, violin, viola, trombone and double bass) and six children playing 'Music Shapers'.

The piece is written in a free-form style. Players are given pitches and instructions for various types of improvisatory gestures they might make around these pitches (glissandi, microtonal pitch shifts, vibrato and various timbral effects – see Figure 6). Entries and exits are cued by the conductor. The professional musicians are placed throughout the hall, with the exception of the double-bass player who remains on stage with the six 'Shaper' players and the conductor. The shapers control a variety of timbres. The timbre of each 'Shaper' is not fixed but changes as the piece progresses. The timbres controlled by the 'Shapers' are based on samples of the instruments played by the musicians, giving the piece a timbral unity. 'Shaper' players may then cause sounds to happen and also moderate aspects of pitch, volume or timbre, to create their own improvisatory expressive 'gestures'.

FIGURE 6. Gestures Score (standard instruments on top, shapers below)

This piece was performed with different groups of children concerts in Boston and New York. In each concert, the children managed to follow the conductors cues, improvise expressively on the instruments and interact musically with each other and with he professional musicians.

HYPERSCORE

Hyperscore composition workshops formed a major part of the Toy Symphony project. It was used extensively throughout the Toy Symphony project as a vehicle for composition activities with children. Hyperscore is a novel and innovative way to introduce children to composition through graphical computer software. During the project, children used Hyperscore software to compose pieces for string orchestra which were then performed in concert in each location.

In order to enable the reader to understand the operation of the software, a relatively full description will be given. Hyperscore was designed and built at the Hyperinstruments research group at MIT Media Lab, Cambridge, Massachusetts, USA by Mary Farbood and Egon Pazstor with some design input from the author[8]. The Hyperscore screen is shown in Figure 7.

[8] Farbood, M. (2001). *Hyperscore: A New Approach to Interactive Computer Generated Music.* Unpublished Masters Thesis, MIT, Cambridge, Mass.

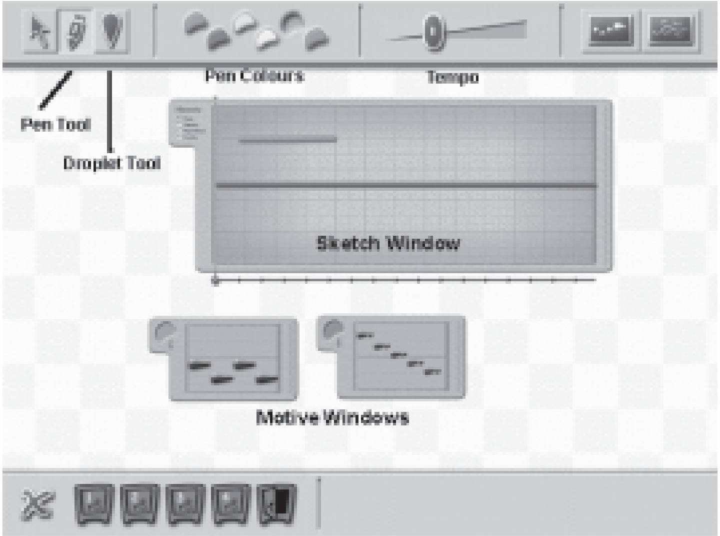

FIGURE 7. Hyperscore

The Hyperscore interface consists of a 'zoomable' working area which may contain two types of 'window', which will be referred to as the 'motive' window and the 'sketch' window. Users may place as many motive and/or sketch windows in the working area as required. They may then hear the results of their work via MIDI playback.

THE MOTIVE WINDOW

Composition activities in the Hyperscore environment proceed on the premise that the piece of music will be based on a number of short musical ideas or motives. Each motive is made by placing notes in the motive window (Figure 8), on a timeline from left to right with pitch top to bottom. The total pitch range available is two octaves divided in semi-tones, with the central horizontal line representing middle 'c'. Notes may be resized from crochets (1/4 notes) up to semibreve (whole note) and down to demi-semiquaver(1/32 notes) and the motive window is marked by a series of vertical lines to indicate relative note values. While the example shown is one measure long, motive windows are extendable to six measures.

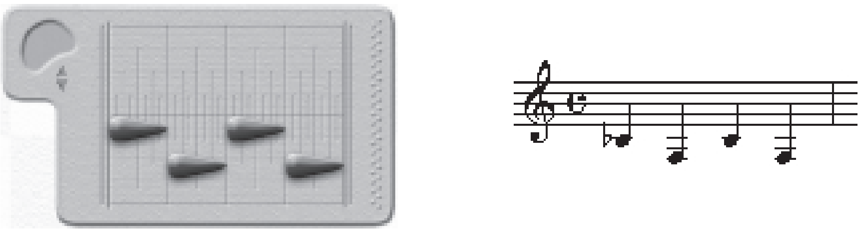

FIGURE 8. The Motive Window

THE SKETCH WINDOW

Users may create as many short ideas, or motives as required. Motives, which are colour coded, may then be placed in the main sketch window by using the mouse to 'draw' them in with the appropriate colour pen. In playback, the play head scrolls from left to right across the sketch window and plays the content of the motive window associated with the coloured stroke, repeating it for the entire length of the stroke. Figure 9 shows the effect of drawing the above motif in the sketch window. The number of times the motif repeats depends on the length of the stroke, in this case three and three-quarter repeats. The pitch at which the motif sounds is reset according to the height at which it is placed in the sketch window. While the motif shown above will sound below 'middle c' in the motive window, in the sketch window in Figure 9, it has been transposed upwards by placing the stroke in the upper part of the window.

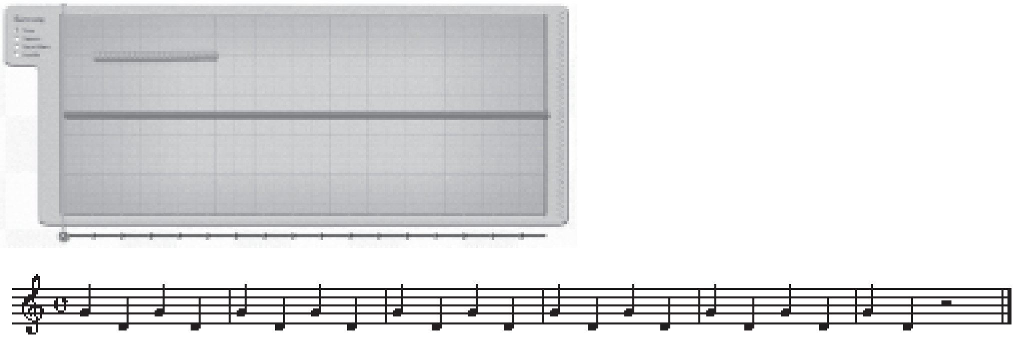

FIGURE 9. The Sketch Window

While the pitch range for playback is reset according to where in the sketch window the motive is placed, internal pitch relationships are maintained. Motives may be layered to create multi-part textures. Currently the interface only supports string sounds. Users may toggle between pizzicato and arco sounds for each stroke. The volume of each stroke may also be adjusted. The sketch window may be extended to allow the creation of pieces up to four or five minutes in length, depending on tempo. Pieces may be exported as MIDI files and viewed in standard music notation using any music scoring software.

CONTOUR

Hyperscore enables the user to explore ideas of contour and melodic shape, again by using the 'drawing' metaphor. Users may draw their motives in the sketch window to some curve or contour. The software will then interpret these strokes according to a 'best-fit' between the content of the particular motive window and the overarching shape of the stroke. Figure 10 shows the effect of a curved line on the short motive described above.

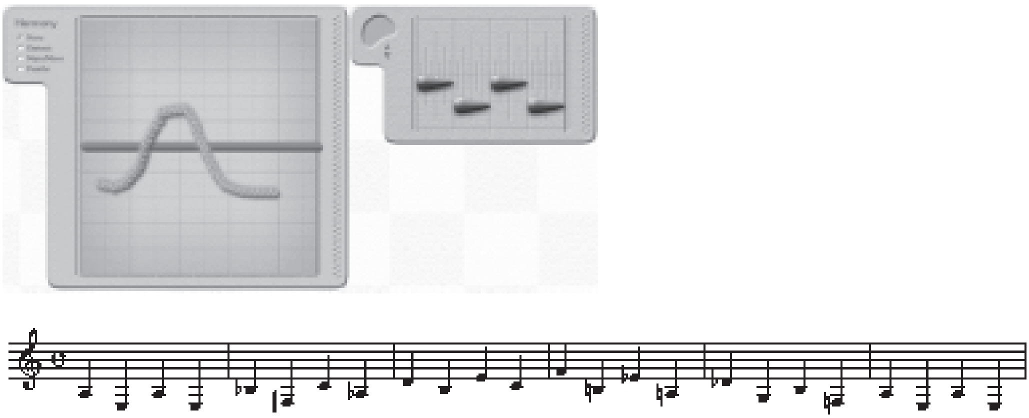

FIGURE 10. Contour in Hyperscore

HARMONY

Users may create multi-part textures by sketching as many simultaneous parts as they like. In multi-part textures, a number of options to facilitate control of harmonic aspects of the music are presented. Users may choose from various harmony types (none, diatonic, major/minor or fourths) and then control harmonic gesture by using the 'harmony line'. This is the horizontal line which runs left to right across the centre of the sketch window. The following set of examples will illustrate how this works with regard to a short example in Major/Minor harmony mode. Figure 11 shows a short piece made with three simple motives.

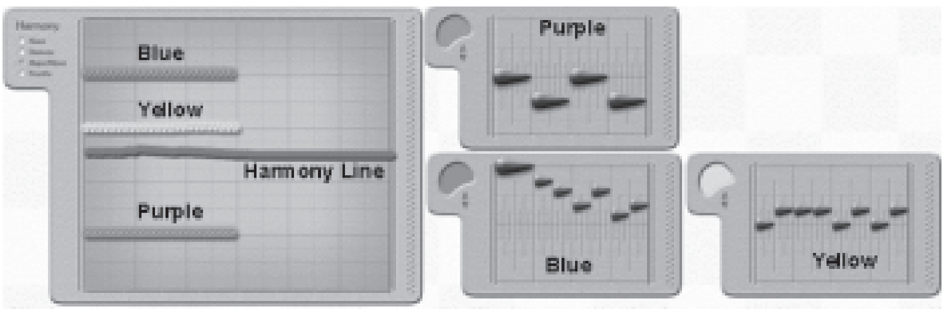

FIGURE 11. The Harmony Line (Example1)

With no manipulation of the harmony line it will sound like this;

FIGURE 12. The Harmony Line (Example 1 score)

It may be clearly seen that each motive is 'quantised' in pitch to the notes of a c triad (by choosing the Major/Minor harmony option) and that each motive simply repeats at the same pitch around an underlying C major chord. Using the harmony line it is possible to manipulate the harmonic underlay in two ways. The first of these allows for local harmonic progressions. In this instance the harmony line is redrawn so as to contain a gentle curve.

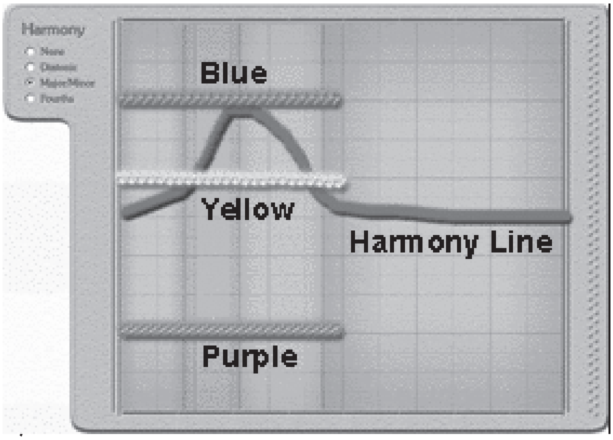

FIGURE 13. The Harmony Line (Example

The rising portion of the curve creates harmonic movement away from the tonic C chord towards the dominant and falling section causes movement back to the tonic. The above piece will now sound like this;

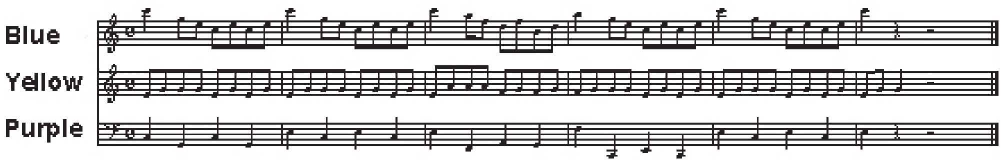

FIGURE 14. The Harmony Line (Example 2 score)

The second type of harmonic manipulation possible is carried out by drawing a sharp peak in the harmony line (Figure 15).

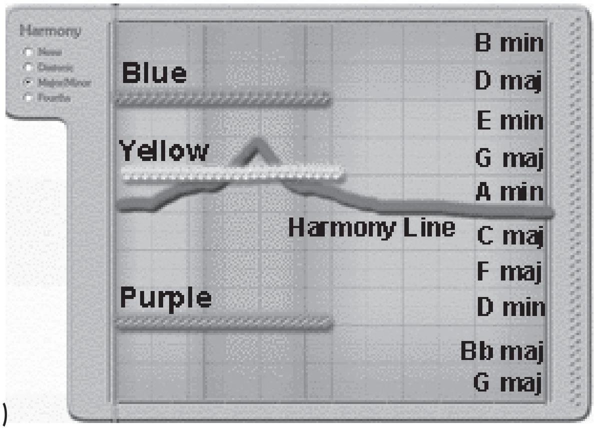

FIGURE 15. The Harmony Line (Example 3)

While a gentle curve will give rise to local harmonic colour, a sharper peak will instigate a key-change or modulation. The height of the peak controls the key into which the music will modulate as shown in Figure 15. Figure 16 shows how this passage will sound.

FIGURE 16. The Harmony Line (Example 3 score)

During the course of the five concerts, over 80 children participated in composition activities using Hyperscore. In each location, three of the childrens compositions were performed as part of the concert. For those children whose work was not performed in the main concert, a series of smaller concerts and public workshops were organized in each location where their works were either performed by string quartet or demonstrated in the Hyperscore environment. Figure 17 shows an example of a completed Hyperscore piece.

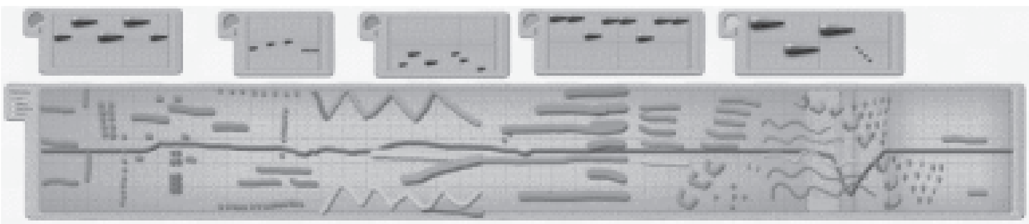

FIGURE 17. 'Creepy Raindrops', composed by ten year old Chelsea.[9]

[9] This piece and many other pieces composed by children using Hyperscore are available in a variety of formats (including MIDI and mp3) at www.toysymphony.net. Hyperscore software is free to download at the same location.

THE CONCERTS

Toy Symphony workshops and performances have been held in five locations to date; Dublin, (Ireland), Glasgow (Scotland), Berlin (Germany), Boston and New York (USA). As well as the performing and composition activities outlined above, a number of other elements made up the concert itself. Professor Machover composed two pieces which formed the opening and closing sections of the concert. The opening piece, called ‘Sparkler’, was written for orchestra and electronics and served to demonstrate the kinds of sonic possibilities offered by the marriage of ‘standard’ orchestra and electronic sound manipulation techniques. The final piece, called ‘Toy Symphony’ was in two movements, written for orchestra, violin solo, childrens choir and children performing on both Music Shapers and Beat Bugs. The solo violin part for the concerts was played by Josua Bell in two concerts and Irish violinist Cora Venus Lunny for the remainder. The violin used for these performances was an electronically augmented ‘Hyperviolin’ developed at the MIT Media Lab. In the case of the choir, vocal parts ranged from standard two part choral writing to various types of vocalizations, clicks, whistles and breath sounds, which were electronically manipulated in real time during the concert. Choirs were given their music some time in advance of the concert and rehearsed with their choir conductors in the normal way. A typical concert program would be as follows:

Sparkler for Orchestra and Electronics – Tod Machover
Nature Suite (Orchestra and Music Shapers) – Jean-Paschal Beintus
Gestures (Small Ensemble and Music Shapers) – Natasha Sinha/Hugo Solis
Nerve (Eight Beat Bugs) – Gil Weinberg
Three ‘Hyperscore’ pieces – composed by children
Toy Symphony (Orchestra, Childrens Choir, Violin, Beat Bugs, Shapers) – Tod Machover
1. Lullaby
2. Choral

THE WORKSHOPS

The workshop process leading to the Toy Symphony concert varied from place to place, depending on the resources available in terms of space and local personnel. However, in general workshops ran over a period of one or two weeks immediately leading up to the concert. Local childrens agencies (for example, the Childrens Museum in Boston, The Ark Childrens Cultural Centre in Dublin) provided space for workshops and in some cases local teachers and composers participated fully in the process, while in other cases workshops were run fully by the Toy Symphony team. Children were usually sourced through contact with these local agencies and were not selected on the basis of any prior musical training, so that a full range of children were exposed to the process.

Workshops were approximately 1 1/2 hours per day. In the case of the two physical interfaces, the only exposure the children had prior to the concert was during the course of these workshops. In the case of Hyperscore, children in Dublin and Boston had some prior experience of using the software before the intensive pre-concert week. In other locations, children used the software for the first time during this week. Where possible, local teachers who were known to the children worked with Toy Symphony personnel to organize and run the workshops.

BEAT BUG WORKSHOPS

The Beat Bugs workshop process typically began with basic rhythm work – clapping and tapping short rhythmic motives. Call and response and circle games were used to encourage the children to begin to improvise rhythmic patterns and to become aware of and interact musically with others in the group. At this point the Bugs were introduced, initially in 'Free-Play' mode. Children experimented by playing simple rhythm patterns on the Bugs both individually and again in circle games. Having mastered the basic Bug playing technique, children were then introduced to the antennae and to the networked aspects of the system. Games were devised where children could make short patterns and send them to other players in the group who could then embellish them using the antennae and send them on. The children learned to become aware of the sounds being made by others in the group and to take turns to improvise. A set of pointing gestures were developed so as to allow children to indicate their intent to each other in performance, rather in the manner of chamber musicians. Finally, when these communication and improvisation skills were secure, the most complex 'Snake' mode was introduced and children learned both the pre-composed rhythmic content and the overall structure of the performance piece, 'Nerve'. In all locations, children mastered both the technical and musical complexities of the piece in five rehearsals and gave a successful concert performance.

MUSIC SHAPER WORKSHOPS

The Music Shaper workshops required a somewhat different approach. As the Shaper group was to perform with a group of musicians from the orchestra who were not available for these workshops, a set of MIDI files were prepared which contained the orchestral music and were used as backing tracks during the workshops. The basic playing technique for Shapers (i.e. squeezing) is extremely simple and took the children very little time to master. The emphasis in workshops was on two aspects, essentially 'when to play' and 'how to play'. Children learned to follow a conductor and to listen for aural cues in the accompaniment part. They learned to distinguish, describe and categorize in a simple way the different sound timbres available in the shapers (long/short sounds, high/low sounds, sounds with slow/fast oscillations etc) and to find appropriate ways to manipulate these using various types of squeezing gestures. Emphasis was again placed on awareness of ones own sound in the overall soundscape and on visual communication with fellow players in short Shaper duet passages.

HYPERSCORE WORKSHOPS

Hyperscore workshops typically involved 8-12 children again for five 90 minute sessions. In Dublin and Boston, some prior outreach work was done, and approximately 20 and 40 children respectively had been exposed to the software, from whom those children to participate in the final week were selected. In the other locations, children received their first exposure to the software during this intensive week. Children were introduced to the software and guided through the composition process by a number of mentors who were composers, musicians or music educators. Children had minimal difficulty in operating/navigating the software, and by the end of the first session had moved on to the actual composition work.

Workshops typically proceeded through a number of stages. At each stage, suggestions were made for core ideas and concepts upon which children might focus as they worked, but children were encouraged to diverge and explore their own ideas at all stages. Mentors generally adopted a reactive rather then proactive role, i.e. they were available to help with working out of details, to draw attention to areas that might need further consideration and to provide support and affirmation throughout the process. In general, they refrained as far as possible from leading the children, or imposing their own compositional priorities. Some examples of the kinds of musical ideas explored include:

- Making motives – pitch, note value, pattern, similarity/difference, 'go-together'
- Sketching melodic lines – pitch, contour, range, instrumental/musical function, timbre, volume
- Building a piece – Beginnings/endings, shape/form/sections, unity/variety, change, surprise, climax, completion, harmony (local and global).

In almost all cases, children successfully completed the task of composing a short (1-3 minute) piece for string orchestra within the five sessions.

SOME OBSERVATIONS

Toy Symphony is a very large project involving multiple participant agencies. Furthermore, it has had as its main focus a high profile public concert in each location to audiences of over a thousand people, along with a series of 'open-house' events, schools and public workshops designed to introduce children and members of the public to the toys and technologies involved. Each concert so far has involved a team of sixteen Toy Symphony personnel plus a wide variety of local collaborators and teachers at a cost in excess of one hundred thousand dollars per concert[10]. Given the wide variety of agendas involved and the pressure of producing a concert performance, it was not possible to include formal observation and data collection as part of the workshop process. However, it is possible to make some informal observations on the nature of the kind of learning experience that children may have had through participation in the workshop and concert experience.

It was very clear from both what the children said and did that participation in the project was a most enjoyable experience for them. It was also apparent that learning of various

[10] Toy Symphony is sponsored by Sega/CSK. The authors participation and ongoing research into aspects of the project has been generously funded by the Irish Higher Education Authority.

kinds and at various levels did, indeed, occur. Obviously, the children acquired a specific body of knowledge relating to the particular instruments themselves, but there was also evidence of more general learning. Children involved in beat Bug and Music Shaper workshops demonstrated increasing awareness of concepts such as pattern, texture, timbre and the various ways these may be manipulated. They learned to follow aural cues and to be aware of fellow musicians in performance and acquired a language for describing their musical experience. As their mastery of the instruments grew so did their musical confidence and self-esteem leading to a growing kinesthetic and musical expressiveness in performance. Listening skills improved, especially for those children involved in Music Shaper workshops, who were consistently required to listen carefully to complex musical textures and to make appropriate expressive musical gestures in response (for example, to make crescendo/ decrescendo gestures at appropriate points in tandem with the orchestra).

Children involved in Hyperscore workshops demonstrated increasing awareness of the musical materials with which they worked and the various ways in which this material could be manipulated. They gained insight into the strategies and processes involved in the composing task and engaged in the types of decision making fundamental to this task (For Example: How to begin/end? How to make a climax? What makes a good bass part/ melody/accompaniment? When/how to 'change'?). While many children first exhibited random doodling behaviors or drew 'visual' patterns, it was remarkable to observe how quickly their focus shifted from the visual to the aural domain so that the software became a vehicle for musical exploration.

One of the most fundamentally striking things about the whole process was the manner in which the use of these technology based resources leveled the playing field between both children with varying degrees of prior musical experience, children and teachers, and children and the professional musicians involved. Children learned that they could acquire a degree of mastery in the musical domain and receive the approval of both their peers and audience. Teachers involved in the workshop process found themselves adopting a less prescriptive role, guiding children towards their own personal means of musical expression within the overall goal rather then closely specifying desired outcomes. The sense that the children were in charge of both their learning and the musical output was in fact one of the most successful aspects of the project.

The technologies discussed here were developed specifically in the context of the Toy Symphony project. However, the outcome of this project indicates that interactive and computer based technologies might have a more varied application in music learning then has generally been the case to date. One could easily imagine a variety of ways in which the technologies described above might be extended and developed to have much wider application. Hyperscore, being a piece of software, has the advantage that it is currently available from the Toy Symphony website (http://www.toysymphony.net) and could be used for compositional activities in schools and a variety of other settings. School ensembles might then perform pieces created using the software. The software itself is presently in the process of being developed and upgraded to facilitate a wider variety of compositional styles. It is also the focus of formal research study by the author examining a variety of teaching and learning approaches, the results of which will be disseminated in the literature. The physical toys in their current form are clearly too expensive and unwieldy to be of practical value to education practitioners, but it is hoped to develop stand-alone versions which might be commercially available. Beat Bugs or similar hand-held percussion instruments might be directly connected to a personal computer with software which would allow the user in school or at home to make, transform and layer rhythmic patterns using a single Bug. Music Shapers or similar might have considerable potential as tools to engender engaged, active listening. Rather then have children listen passively to music, it would be possible to create a more meaningful experience by having them use Shapers to start or stop parts in tandem with recordings (to cue subject entries in a fugue for example), or even control expressive aspects of voices in an orchestral texture, effectively 're-creating' parts of the piece to which they are listening.

It is not suggested that these technologies would supplant traditional methodologies or replace traditional instrumental and ensemble musical activities current throughout the music education spectrum. Rather, technology can be used to enhance and complement these approaches. A technology-based approach could allow children to explore higher-level aspects of music, which might be difficult to access without many years of traditional study. Such an approach might also provide a different route to music learning for children for whom the traditional approaches have been less successful. In its exploration of these alternative paths to musical learning, it is hoped that Toy Symphony represents the beginning of a dialogue between musicians, teachers, technologists and children which will ultimately lead to appropriate and meaningful use of technology as another tool in our music teaching and learning repertoire.

FINAL NOTE

Further information on issues related to technology in Music Education may be found at a variety of online sources: A description of various commercially available music software and hardware is to be found at

http://www.lentines.com/articles/article_front_page.htm

The Association for Technology in Music Instruction provide a range of information and resources for music teachers at

http://www.music.org/atmi/

The Music Educators National Conference offer a list of publications relating to the deployment of technology resources in the classroom at

http://www.music.org/atmi/

A range of online music games and activities (including software designed by the author) may be found on the BBC website

http://www.bbc.co.uk/games/category.shtml?music

Further information about the author is at

http://www.cs.tcd.ie/crite/personal/KevinJennings.htm

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Paradiso, J. and Gershenfeld, N., (1997). Musical Applications of Electric Field Sensing, *Computer Music Journal*, 21,(2), MIT , Cambridge Massachusetts, USA.

Weinberg, G., (2002). Playpens, Fireflies and Squeezables. New Musical Instruments for Bridging the Joyful and the Thoughtful. *Leonardo Music Journal*,12

Weinberg, G., Aimi, R., Jennings, K., (2002). The Beatbug Network – A Rhythmic System for Interdependent Group Collaboration. *Proceedings of the 2002 Conference on New Interfaces for Musical Expression (NIME 02),* Dublin, Ireland, May 24-26, 2002

Farbood, M. (2001). *Hyperscore: A New Approach to Interactive Computer Generated Music*. Unpublished Masters Thesis, MIT, Cambridge, Massachusetts, USA

WWW-BASED REFERENCES AND RESOURCES:

The Hands. Michel Waisvisz

http://www.xs4all.nl/~mwais/

Sensorband

http://www.sensorband.com/
http://www.toysymphony.net
http://web.media.mit.edu/~tod/
http://www.creatingmusic.com/
http://www.lentines.com/articles/article_front_page.htm
http://www.music.org/atmi
http://www.music.org/atmi/
http://www.bbc.co.uk/games/category.shtml?music
http://www.cs.tcd.ie/crite/personal/KevinJennings.htm

ABOUT THE AUTHOR

Kevin Jennings is a musician, teacher and music educator. He has taught in Ireland, the UK, Europe and the USA in both school and other settings and has been extensively involved with childrens choirs, orchestras, music theatre productions and other childrens performing groups. He is currently a research fellow at Trinity College Dublin where he is pursuing research into applications of computers and associated technologies for music teaching and learning.

SUMMARIES