***jam2jam:* Networked Improvisational Musical Environments**
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**Abstract**

This paper examines the emerging concept of networked improvisation. In particular it reports on the development of *jam2jam* software and its associated research projects. These projects offer a proof of concept over a 3-year trail period of the idea of collaborative musical environments on a network and describe the effects on meaningful engagement in music making. The paper follows a structure presented at the practical workshop at MISTEC and highlights the emerging learning opportunities of real-time improvisation using digital instruments connected via electronic networks and the broad range of school and community applications further illustrated by the series of ongoing case studies and its potential as a new concept for music learning.

It is proposed that the concept of networked improvisational musical environments adds a new dimension of online music learning that incorporates the advantages of real time ensemble activity into music technology learning experiences. Furthermore the researchers suggest that the emerging learning opportunities of real-time improvisation using digital instruments connected via electronic networks that use algorithmic musical structures become curriculum structures that frame the musical knowledge and focus and engage the learner in an interactive musical experience.

***jam2jam:* Networked Improvisational Musical Environments**

**Introduction**

The common impression of music technologies is one of individual work at a computer. In contrast to this, networked computers provide a vehicle for collaborative music making with the educational advantages of ensemble experiences. When combined with semi-structured

experiential music making practices the result is Networked Improvisation. This paper based upon a practical demonstration presented at MISTEC 2006 describes networked improvisation using networked computers and *jam2jam* software (Brown, Sorensen, & Dillon, 2002). This software and the associated research projects offer a 'proof of concept' over a 5-year period of the idea of collaborative musical environments on a network and the effects on meaningful and engaging music making. The description of the workshop highlights the emerging learning opportunities of real-time improvisation using digital instruments connected via electronic networks and the broad range of school and community applications illustrated by the series of case studies and the ideas potential as a new concept for music learning.

The overall aim of the paper is to introduce and define the concept of networked improvisational musical environments as a new dimension of online music learning that incorporates the advantages of real time ensemble activity into music technology learning experiences. The paper aims to introduce and define these new opportunities for interactive and collaborative aural perception experiences and focuses on demonstrating the emerging learning opportunities of real-time improvisation using digital instruments connected via electronic networks and exploring the use of algorithmic musical structures as curriculum structures that frame the musical knowledge and focus and engage the learner in an interactive musical experience. The research suggests that Networked Improvisational Music Environments (NIME's) that model style and genre in an accessible way as virtual and present collaborative learning spaces are able to exploit the interactive qualities of ICT to provide supportive learning environments for action and reflection.

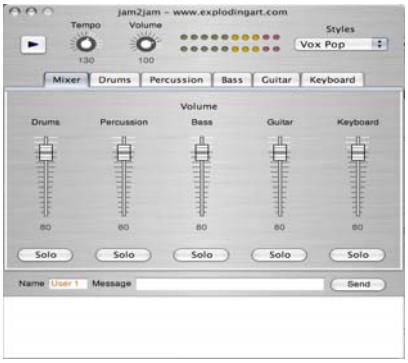


**Figure 1**

**What is Jam2jam?**

Computer musicians like Iannis Xenakis (Xenakis, 1991) and David Cope (Cope, 1992) have used generative algorithms to make complex electronic music composition. Advances in computer technology have made it possible to design music algorithms based upon specific pitch, timbre and rhythmic qualities that can be manipulated in real time with a simple interface that a child can control. *jam2jam* is a software program that uses these ideas and involves what is called Networked Improvisation, which *'can be broadly described as collaborative music making over a computer network'* (S. Dillon & Brown, In Press). With this software users manipulate sliders and dials and influence changes in music in real time. This enables the opportunity for participants to interact with the sound possibilities of the chosen musical style as a focused musical environment. Essentially by moving a slider or dial the user can change the intensity of the musical activity across musical elements such as rhythm, harmony, timbre and volume and the changes they make will respond within the framework of the musical style parameters, updating and recomposing within the timeframe of a quaver/eighth note. This enables the users to play within the style and to hear and influence the shape and structure of the sound. Whilst real time performance using a computer is not new, what is different about this software is that through utilising a network you can create virtual ensembles, which are simultaneously collaborative and interactive.

*jam2jam* was developed using philosophical design principals based on an understanding of meaning drawn from both software based and live music experiences (S. C. Dillon, 2001b) and research about how professional composers use technology in creative production (Brown, 2003). New music technologies have for centuries provided new expressive possibilities and an environment where humans can be playful. With *jam2jam* users can play with complex or simple musical ideas interact with the musical elements and hear the changes immediately doing so collaboratively in a virtual ensemble and both live and virtual performances.

What is significant about this case is that it enables music to be present in a conversation about music. Users can focus on the particular configuration of the parameters of musical style that make styles/genres unique. It allows the groups of users and teachers the opportunity to both play as an ensemble and discuss the ensemble performance simultaneously. The performance is continuous and so conversations about the sound can occur with the music present. It also allows a 'What if?' scenario: what if there was more bass? What if the tempo was slower? What if we changed the timbre of the keyboard?

The conversation becomes necessarily focused around using musical terms and musical concepts, which pedagogically scaffolds the users reflection in and on the activity of music making (Schon, 1984). For music education pedagogy, creating a networked musical environment allows teachers to focus attention on the expressive qualities of composition and leading to a musical conversation about the music with the music present. Consequently the answer to each of the 'what if' questions can be heard and discussed. Whilst we can focus listeners on musical ideas when playing a recording with this approach in this case we create a new kind of experience where the users can interact with the style/genre in a collaborative and safe environment where feedback is immediate. The software establishes a relationship

between the users ears, gesture and the musical ideas encapsulated by the algorithm. To date over a thousand children between the ages of 4 and 16 have used this software within moments of its introduction. Many adults too have also been engaged in interacting with the simple interface and music making. What this research has alerted us to is that this kind of music technology allows us to be simultaneously immersed and apart from the experience of music making. It allows teachers to focus students' attention in an immersive environment and engage them with collaborative music making. It provides an opportunity to play in a playground filled with musical experiences which can be engaged with meaningfully.

There have been continuous iterations of research case studies process for this research located in Australia, USA and European contexts for five years with the data from each cycle flowing back into the software design and the associated curriculum structure. There have currently been four iterations of field study. The research has been supported by an Apple University Consortium development grant, a philanthropic grant from the USA based Verizon Wireless and more recently it has been included as part of the Creative Communities research at the Australasian Collaborative Research Centre for Interaction Design (ACID.

**Background**

The initial development of *jam2jam* began with a survey of the musical tastes of a group of children between the ages of 8-14 in a multi racial community in Delaware, Ohio in the USA as part of the Delaware Children's Music Festival. These surveys of 'the music they liked' resulted in the researchers purchasing the Compact Discs and completing a rule based analysis of the styles. This analysis was then converted to numerical values and algorithms were constructed and used as a structure for the software. The algorithms propose the intensity of range of each style. For example in the Grunge style the snare drum at low

intensity plays a cross stick rim timbre on the second and fourth beat and at high intensity the sound becomes a gated snare sound and plays rhythmic quaver/eighth note triplets. In between these are characteristic rhythmic materials that are less complex than the extreme (triplets). This procedure is replicated across five instruments eg drums, percussion, bass, guitar and keyboard. The melodic instruments have algorithms for pitch organisation within the possibilities of the style. These algorithms became the recipes or lesson plans for interactive music making where the student's gestures control the intensity of the music as it composes in real time. A simple interface was designed (See figure 1) with a page for each instrument and the mixer. The interface primarily uses dials and slider, with radio buttons for timbrel/instrument selection.

Once the software was built and installed we observed students using it videotaping their interaction and interviewing both children and teachers. Observations, which fed into the developmental design, were drawn from these on a daily basis with the interface and sound engine being regularly updated to accommodate students and teacher requirements. The principals of observation and analysis were based upon a theory of meaningful engagement (See: Meaningful Engagement Matrix). These adjustments were applied to the software, the curriculum design and to the teacher's behaviour. The concept of meaningful engagement, which has emerged from this process, provides an effective tool for identifying the location of meaning and describing modes of creative engagement.

**Things that surprise you!**

When we are involved in qualitative research methods the problems of deep insider research bias is often a concern for the researcher (Edwards, 1999). It is very easy with this kind of research involving both the mathematical aspects of computer programming and the human-

social- community interaction to overlook the obvious and play down the negative aspects of the case. In this research a deliberate search for 'surprising' observations have provided critical developmental guidance principals. For example in our first iteration we did not consider the implications for literacy for students using jam2jam's chat boxes. The students' engagement with simultaneously listening and influencing musical change and using the chat boxes to talk about music was a profound insight into instructional design.

Furthermore at Brisbane's 'Out of the Box' children's arts festival we noticed the need for teachers to be able to conceal radical changes in an algorithm so that the teaching and learning could focus on the music. Our response in software design was to allow functions such as tempo, which potential could damage the experience for the hip hop dancers they were accompanying, to be able to be turned on and off as an option by the teacher. The teacher is able to construct and select the particular areas of musical knowledge that the students are able to engage with. In this case they were able to focus on creating a good dance groove for the hip-hop dancers and a solid bed for the MC's to perform their freestyle raps. It has been divergent and negative case experiences that form part of each iteration and internal cycle of the research that have produced the most interesting changes to the interface and engine, the curriculum and the teachers interpretation of these relationship in practice. The meaningful engagement matrix (Appendix 1) has emerged from this research as a framework for examining the interaction of these factors and provided a language for describing it and feeding back into the practice and design.

**A 'rinky-dink MIDI toy.**

As *jam2jam*'s sound engine uses java MIDI sounds the quality of the timbres available is in music technology slang considered 'rinky-dink'. Also *jam2jam*'s simplicity of interface

design perhaps further trivializes the capacity of the software. The incorporation of a Meaningful engagement and modeling philosophy has however incorporated a more significant factor in the software's use which has demonstrated a robustness of engagement and sustained interaction beyond it's apparent simplicity and lower quality sounds. Whilst the project team are currently constructing a more realistic and high quality audio sound engine and a more 'professional' interface, jam2jam in its more basic form allows us to eliminate the variable of quality sound samples as a primary engagement factor in the process and focus on non timbrel qualities of structure and space.

Having provided a background and philosophical perspective for the concept of networked improvisation in this next section I will describe the process of interaction in solo and networked environments presented at the workshop, focusing on their relationship to the Meaningful Engagement Matrix (Appendix 1) and its impact on designing software for collaborative learning.

**Solo Jamming**

Metcalf (Abbs, 1990) describes the notion of building on the natural aesthetic responses of children and engaging with the intrinsic qualities of music making. So we believe it should be with generative music making tools like *jam2jam*, playfulness is essential. We believe that the nature of interface design should be like the relationship that a young child has with a drum: the child will make a sound with the drum and get pleasure and perhaps flow (Csikszentmihalyi, 1994) from the sounds they make. What occurs beyond the spontaneous and intrinsic enquiry driven by the users curiosity is the potential for the drum to provide sufficient challenge and limit the boredom of exhausting the possibilities of the relationship with the instrument. It is at this point that the curriculum design and teaching relationship

begin. These provide a focus on particular aspects of musical knowledge that can be encountered through playing with the instrument and the opportunity to reflect on the quality and value of the music made.

It has been observed over repeated research iterations that using jam2jam as a performance and interactive aural perception learning tool for individual users builds on the sense of personal meaning that can be experienced using the software (S. Dillon, 2003, 2004).

The kinds of activities that have been used with jam2jam are:

1) Using the software to learn about concepts of groove/rhythmic feel in contemporary music.
2) Using the software to directly experience the meaning of music and sound elements such as tempo, mixing of volumes, timbrel/instrument choice, chord progressions and density.
3) Using the software as a generative tool for composition of grooves, sequences of MIDI information for later use in other programs or lyrics/melody writing.
4) As an accompaniment for live performance using acoustic/electric instruments.
5) As an accompaniment or live performance tool for MC/ rap performance.

Solo activity with generative software has the added quality of performativity and qualities of improvisation, which add to the immediacy, and 'live-ness' of the interaction. It also enables a novice user to play with a more accomplished instrumental performer and interact successfully without risk of error. Brown's notion of Modes of engagement (Brown, 2000) which has been applied to this solo interaction process identifies the capacity for the process to engage in the following ways: participation, directing activity, exploration and selection. Whilst this is a solo activity the interactions represent a relationship with a responsive and improvisational- virtual partner that replicates human spontaneous response. It is therefore

possible to mimic collaborative activity and practice it. The networked functions of the software take this notion further still.

**The concept of networked improvisation.**

Networked improvisation and its associated environment from a technical perspective can be defined as online multi-user software environment for real-time asynchronous music making (S. Dillon & Brown, In Press). Designing meaningful interaction promotes a range of modes of engagement (Brown, 2000, 2003). Musical knowledge is encountered through real-time experience constructed and focused by the generative musical algorithm because it directs the 'score'. Furthermore networked environments provide opportunities for social and cultural meaning (S. Dillon, 2003, 2004).

Networked improvisational experiences define a contemporary musicianship, which embraces the computer as instrument that can be used in live performance with both acoustic/electric instruments and other network users. The network itself becomes a site for a virtual ensemble where users can experience interaction between 'players' in real time. With networked improvisation cyberspace becomes a venue for performance, when the Internet or local area network are used by groups of performers sharing an ensemble instrument perform online. We have also observed a performance in two distant locations where groups of computers on the network simultaneously 'jammed' with users in another location alongside 'live' acoustic performers in both locations.

Networked experiences promote:

1) Ensemble experience through sonic interaction.
2) Problem solving skills through listening and action.
3) Reflection on sound production and in sound production simultaneously.

These experiences involve all modes of creative engagement involving; participation, directing activity, exploration and selection. Whilst in particular social meaning is evidenced in the ensemble experience the performative aspect draws a reciprocal interaction with the community of peers and wider community engendering culturally meaningful outcomes.

**Current Outcomes**

From the four iterations of the case studies a number of refereed articles and book chapters have been produced examining meaningful engagement with music technology (S. Dillon, 2003, 2004, 2005; S. Dillon & Brown, In Press; S. C. Dillon, 2001a) there have been critical reviews from Macworld and Music in Action (Brown, In Press; Holloway, 2003. And Andrew Brown has developed hybrid methodological strategies for case studies involving human and technological communities {Brown, In Press #219)

**What if…?**

The idea of networked environments proposes many questions for music education. In this section I would like to simply ask what would happen if the research continued along its present development pathway and what the implications might be for music learning and teaching

What if…

1) A suite of rule based musical styles/forms was turned into algorithms? For example: a sonata algorithm. Cope has done this (Cope, 1992) Or a chaos algorithm (Xenakis, 1991) or a minimalist algorithm, a medieval algorithm, a Cage algorithm  etc.

2) The sound source was a sample engine? Any sound would be possible from a soundscape to an orchestral, to a rock sound.

3) The interface was kinesthetic? And responded to touch and gesture in an expressive refined way.

**The future**

The future of NIME's is exciting and lies in the potential for these environments to replicate complex musical systems and engage participants in musical understandings that link gesture and sound with concepts of musical knowledge that are constructed within the algorithm and the interface. The dynamic development of Network Improvisation involve designs which apply philosophical and pedagogical principles that encourage and sustain meaningful and engaging interaction and are sufficiently complex to allow the revisiting of musical knowledge at progressively deeper levels.

**Conclusion**

In conclusion we propose that *jam2jam* is a proof of concept model of a networked improvisational musical environment. This idea suggests a 'contemporary musicianship, which embraces the computer as an instrument, the network as an ensemble and cyberspace as venue for performance. We suggest that these concepts present great potential for music learning as a means of providing access to complex musical structures facilitated through simple interfaces. It provides the opportunity for learners to be creatively immersed in the simultaneous act of listening and performance. *jam2jam* represents an opportunity for music-makers to have interactive experiences with musical knowledge in a way not otherwise previously available. It enables children, adults and the disabled to enter into a collaborative community where technology mediates a live ensemble performance. The experience could be an ostinato pumping out hip-hop grooves or a Xenakis chaos algorithm. What is important here is the access that the users have to meaningful engagement with others in the production of music.

**Author's note:** Writing about a workshop experience like this is a difficult process because of the immediacy of the understanding that is obvious in a live sonic participatory demonstration. This article is abstract because of this. Please download a shareware copy of jam2jam from: http://www.explodingart.com/ and play with it. This will give the reader a better understanding of the concept and software that is discussed here. Please email me: sc.dillon@qut.edu.au if you have any questions about the software or the research.

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(Please note the projects presented here are not an attempt to be self-referential but to place the paper in the context of a body of research in these areas.)

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# Appendix 1
# Meaningful Engagement Matrix

| | Appreciate | Direct | Explore | Participate | Select |
|---|---|---|---|---|---|
| Personal | | | | | |
| Social | | | | | |
| Cultural | | | | | |

- An appreciator – listening carefully to music and analysing music representations.
- A director – managing music making activities
- An explorer – searching through musical possibilities and assessing their value
- A participant – involved in intuitive music making
- A selector – making decisions about the value of music or musical elements
- Personal – the activity is intrinsically enjoyable.
- Social – the activity connects the student with others and these relationships are valued.
- Cultural – the activity is regarded as valuable by the community and, by participating (or succeeding) in it, the student achieves a sense that they too are important.