# Towards Generative Sound for Interactive Multimedia

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October 1996

## Abstract

Generative sound is derived from mathematical formulae creating new sonic structures from a simple set of instructions.

This paper outlines the processes that were devised for the generative score and sound design for *OMA: Ausländer und Staatenlose*. It explores in brief the influence of artists in the development of digital media and the role *chance* plays in the evolution of creative ideas.

In particular, the paper focuses on the generative software, KoanPro, which the author has used extensively throughout the course of his research.

The body of work developed as a result of this research, *Lost Time Accident*, was chosen as the merit award winner in the Time-Based category of the CAT 3rd Digital Imaging Awards, 1996, Melbourne, Australia. *Lost Time Accident* was described as "…truly innovative and a great marriage between 'sound' content and technical competence."

The ideas and systems discussed here are further advanced in the papers and lectures titled, *The Politics of Dissonance*, *Lost in Sound* and *Sound Breeding*.

An article derived from this paper, *Lost Time Accidents: A journey towards self-evolving, generative music*, was published by *Some Such*, Journal of New Musique Australia (December 1996).

## Introduction

"The act of playing the game changes the rules."[1] Computers have the wonderful ability to make sense of distortion and turbulence, to fathom phenomena that we can but guide. And guide we do, by design and invention the algorithmic creations that process the complex array of tasks we set aside for them.

Artists have played an important role in perceiving and ultimately developing new applications for computers. The most significant and obvious of these developments are evident within the multimedia, virtual reality, film and music industries. Alongside these often epic achievements, artists have been utilising new technologies to further their long-time fascination with *chance*.

In the late 19th Century, Ada Augusta,[2] inspired by the work of Charles Babbage, considered the possibility of a machine that could write music. That if one could define "the fundamental relations of pitched sounds in the science of harmony and of music composition … [then] … the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent."[3]

In 1932, the journal of the League of Composers, *Modern Music*, published *Electricity, a liberator of music*, an essay by the Russian composer and musicologist Joseph Schillinger. Schillinger believed that artistic creation "could be converted into a process of combining mathematically quantifiable factors of production."[4]

Nearly one hundred years after Babbage's work on the Analytical Engine, with avant-garde composers such as Karlheinz Stockhausen and Pierre Boulez at the helm, machines for composing, processing and analysing music were being constructed. Music, in particular electronic music, evolved into a science. Computers followed and became integral to the compositional process.


## Origins

Perhaps the earliest known chance driven composer was the self-generating Aeolian harp. It is a Greek instrument named after Aeolis, the God of the Winds. It consisted of a box with strings drawn across its openings. On windy days the strings would vibrate, modulating the air enough to create a soft, soothing chord. It would become to be known as the *Aeolian Mood*, or mode.

In the 1940's, Muzak®[5] developed *Stimulus Progression* programming, an "elaborate system that arranges songs according to tempo and time of day, taking into account the typical lulls that hit workers mid-morning and mid-afternoon."[6] Every hour of every working day contained a mix of songs and instrumentals that varied enough to avoid repetition. Although the music was not generative, the programming sought to create the sense of an ever-changing range of moods, within fixed intervals, to maintain worker morale and productivity.

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[1] Gleick, J 1987, *Chaos: The Making of a New Science*, New York: Penguin Books.

[2] Countess of Lovelace and daughter of the poet Lord Byron.

[3] Pratt, V 1987, *Thinking Machines*, Oxford: Basil Blackwell.

[4] Stuckenschmidt, H 1969, *Twentieth Century Music*, World University Library.

[5] General George Squier took out a US patent for the transmission background music, Muzak, in the early 1920s.

[6] Davis, B 1996, *Hold The Elevator Muzak Gets Hip*, [online] http://www.timecast.com/story/muzak1.html [Accessed October 1996].

Stockhausen is considered to have pioneered serial techniques[7] in electronic music, a means by which a short series of notes, duration, dynamics, timbres, etc., are manipulated by a combination of live instruments with electronics and multimedia performance. Composer, John Cage and many others inspired by his work, went on to create soundscapes comprised of arbitrary noise often punctuated by silence. These works were designed to be random, engaging the listener within the sonic construct of the environment they were either performed or installed within. But it was the minimalist composer, Brian Eno, who gave the elements of chance a more global audience.

Eno predicted that children of the 21st Century will wonder why we listened to the same music over and over again. Eno, since his early tape loop experiments, was creating systems "to make music with materials [he] specified, but in combinations and interactions that [he] hadn't."[8] Originally inspired by Steve Reich's 1960's tape pieces *Come Out* and *It's Gonna Rain*, Eno went on to establish principles of composition that influenced the direction and proliferation of what is now commonly known as ambient music. He went on to became increasingly interested in the possibilities for *publishing musical systems* as opposed to pieces that had a definable beginning and end.

In 1995 the UK based SSEYO Ltd, sent Eno a CD of ambient music that they had created with their proprietary generative music software, Koan Pro™. Eno, impressed by what he heard, began working with KoanPro and released in mid-1996, *Generative Music 1* on diskette. His vision, to distribute systems for music that were never to be heard the same twice, had been realised.

Koan's generative music had its origins in 1986 when SSEYO founders, Tim and Peter Cole, "wanted to create a computer music system which could affect you on an emotional level, by enhancing or filtering your perceptions, and provide ever-changing, eventually interactive, music." In 1990 they developed the *SSEYO Koan Music Engine* (SKME) that enables the composition and harmonisation of music in real-time according to parameters set by the composer.

Koan Pro, at the time of writing, offers up to 150 "variable controls to influence and produce … music as it goes. The values of these controls, some of which are time sensitive, are written into a SSEYO Koan 'piece' ... They determine the notes and melodies generated when you play the 'piece' through the … SKME."

## Generative Music and the Web

SSEYO's mission was "…to create ever-changing beautiful music … that can be integrated within a personal aural environment. The experiential and personal nature of music the SKME generates is ideally suited to WWW sites, and 3D WWW virtual worlds and gaming."

Web sites that contain Koan music are heard with a browser plugin. The plugin is invoked by an embedded Koan file, which in turn calls up sounds from your soundcard. If you are using anything less than a General MIDI[9] capable soundcard Koan files will sound terrible.

The plugin and all Koan player software contains the SKME. A Web site designed with Koan enhanced audio can provide new aural spaces every time it is visited. Koan files are generally smaller than MIDI files. An eight hour piece could conceivably take up less than 10k of valuable disk space.

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[7] Serialism, a method of composition by which a short series of notes, duration's, dynamics, timbres, etc., is manipulated by various means.
[8] Eno, B 1996, *Generative Music*, Opal Ltd.
[9] General MIDI, a set of sound patches agreed to by all major international manufacturers.

The Web is transformed slightly by Koan. You can create with Koan anything from ambient, contemplative soundscapes to beat driven, high energy back tracks. You can do generative sound design for Web sites! The site you surf tomorrow would be different to the one you heard today.

## Towards Interactive Composition

The concept of interactive composition is not a new one. Improvised music is perhaps the most popular and well-known form of interactive composition. It is mostly reliant on musicians processing and communicating musical ideas as fast as they possibly can. Computers can process much more information faster and over longer periods of time.

If I could provide a computer with a foundation-stone, it could perhaps construct an entire city whilst I populate it with new ideas. That city would continue to grow, to mutate and evolve in ways that I could not imagine. I wanted to improvise with the computer, to develop a rapport with it in such a way that it would stimulate and challenge me towards ideas, concepts and systems I would not have come close to realising.

I had a lot of experience with improvised music, having spent several years playing, jamming and experimenting with many different types of musicians in the 80s. In the 90s I wanted more information, more processing … I knew what I wanted and I wanted to get there fast. As far as I was concerned, improvisation was interactive composition. The idea was not necessarily to remove the human factor, but to enhance, even free it. The task, then, was to translate the performative, gestural and communicative qualities, unique to human interaction, to interactions with software. I looked to Europe…

On February 2, 1994, the contemporary Austrian composer, Karlheinz Essl, performed *Lexikon-Sonate* as a live broadcast during the radio program *Kunstradio - Radiokunst*. Essl was exploring the performative aspects of "interactive real-time composition". Whereas Koan pieces re-generate, or mutate pre-defined rhythms, melodies and chords, Essl's *Lexikon-Sonate* never repeats itself, providing "…a challenge to invent a particular performance situation that utilizes … interactive facilities…".

Essl used a Bösendorfer SE Grand Piano and radio listener as players. Listeners could interact with a computer by dialling a certain telephone number. "Whenever a call came through, *Lexikon-Sonate* would change its compositional behaviour by adding a new and randomly selected module into its combination chain. In this way the totality of radio listeners would *govern* the form of the music, even though nobody could know the exact effect of their contribution."

At the heart of Essl's system is the graphical programming language called Max. As powerful as this application is, I could not afford the time to learn it. In addition, it was only available for Macs and I did not know anyone (at the time of writing) whom I could work with to develop the systems I was exploring. I stuck by Koan.

If Koan changes the *compositional behaviour* of a sound piece and other human participants, and I contribute to the sounds it would work with, are we not creating a self-generating *interactive composition* much like Essl's? I forged ahead with Koan.

Though primitive in nature to Essl's work, I devised a simple system to enable me to improvise with Koan. I hooked up Koan via MIDI to various synthesisers and a sampler. Each external device was fed by an individual pre-composed track within Koan.

The compositions were derived from five notes relocated anagramatically and to create compound chromatic clusters or chords. They were then dispersed over nine bars which were in turn cycled

over 81 bars. The compositions were then looped generating fresh variations of their 45-note, 9-chord, 81-bar seedlings.

Real-time changes in pitch, semitone shifts, mutation factors, panning, velocity and numerous other parameters were made. Pre-sampled audio files were inserted into Koan tracks, and sounds on all the outboard equipment were changed, modulated, tweaked and re-tweaked to taste. All this was done whilst retaining the integrity of the original composition, but allowing for change as determined by Koan and the data it was processing over the 5-10 minutes of each composition.

After several experiments in both the studio and in live performance/installations I arrived at a body of work I titled, *Lost Time Accident*.[10] This was the result, I am positive, of a synergy between composer and machine based on the fundamental principles of improvisation.

## A generative acoustic for multimedia and VR content

Although interactive and often engaging, multimedia CD-ROM titles generally offer static, repetitive experiences. Many new games on the market incorporate basic AI[11] and Fuzzy Logic[12] methodologies enabling the players experiences to be *learned*.

Given the generative qualities of Koan and the compositions and soundscapes created with it, there is great potential for the its implementation within multimedia content. The creation of an acoustic space that never sounds the same twice offers the user a refreshing experience in addition to interactive content. Generative music is engaging. A fresh aural environment is created whenever, say, a CD-ROM title is fired-up, providing for new experiences and creative use of the content.

Several web sites already employ generative music, but very little development has been done in collaboration with other forms of multimedia content. It is my feeling that a whole new area of creative content creation is yet to be extensively explored.

Imagine this… you fire-up your favourite CD-ROM or game title. You know all the introduction screens will be the same, the options and paths will be mapped out for you, but the majority of sounds and all of the music will never be heard the same twice. In fact, you might want to get back into that CD-ROM or game just to hear where the music might be going, and perhaps where it might take you.

## Future music?

Will generative music influence the music we will listen to into the next century? Will Eno's vision for a commonplace generative music be realised? Will children be asking us questions about our current listening habits?

With ready access to software that provides for the creation of generative music we may find it filtering more and more into public spaces, including multimedia and web sites, than on radio. The genre is not yet fully defined, but its scope is broad.

Generative music adds to the creation of more holistic environments and experiences for people; whether it be a shopping centre, public mall or restaurant. These environments always change.

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[10] These compositions were released as on-demand RealAudio files in 1996. In 1998 they were released as freely available MP3 files. They have since been released on CD, *Age 2 Wonder at*, Secession Records, 1998.
[11] Artificial Intelligence.
[12] Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth - truth values between *completely true* and *completely false*.

Why shouldn't the music? The Muzak corporation has successfully integrated generative music concepts into to their *Stimulus Progression* programming evident in the *Music Plus*[13] and *On-Premises*[14] catalogue.

But much of our urban environments contain pre-constructed acoustic experiences. Shopping malls throughout the world are rife with re-constructed environments. Why create a lie for our ears? Generative music, and in particular the *Lost Time Accident* compositions, are not trying to replicate nature nor construct a pre-determined environment. They are comprised of the sounds and influences they were created in. Could such a process be integrated into the production of an opera, multimedia and virtual domains?

Walk through and listen to most urban neighbourhoods and you will hear a rich diversity of language. Much like an ever-changing piece of music, language is perhaps the most original form of generative music; it evolves, mutates, and interacts, *transforming the human landscape*, playing the game and changing the rules.


## Postscript

Since this paper was written there have been several significant developments that should be noted.

The creation of generative soundscapes for the Web is now possible with scripted algorithms (eg. Javascript) pulling musical statements, or combinations of pre-sampled sounds from the Beatnik audio engine[15]. In addition, the Koan Audio Engine now supports synthesis that can be controlled in real-time by the SKME.

Since 1997 Muzak have been changing their corporate image. Muzak staff are no longer considered scientists, but designers in the business of Audio Architecture. Muzak also supports 60 individual music channels delivered by satellite.

A freeware, PC version of Max, PD (Pure Data) has been created by one of the original authors of Max, Miller Puckette. PD is designed purely for "live musical and multimedia performances."[16]

In recent years, generative art has become a genre or creative discipline in its own right: annual international conferences; generative sound and image software freely available; generative architecture; international collaborations; elaborate, algorithmically-driven virtual worlds – generation has indeed become a digital aesthetic.

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[13] Muzak's 16 Channels of Satellite Business Music.

[14] Muzak's Business Music selection.

[15] General MIDI compatible audio plugin with extensive interactive capabilities, [online] http://www.beatnik.com [Accessed 24 July 2000].

[16] Puckette, M (n.d.), [online] http://lena.ucsd.edu/~msp/ [Accessed 24 July 2000].

# Resources

Algorithmic Arts Software for Genetic Music

Software, music, mailing lists and a great selection of links from algorithmic arts enthusiasts.

[online] http://geneticmusic.com [Accessed 24 July 2000].


First Iteration

First Iteration was the first in a series of symposia for those interested in generative computational processes in the electronic arts. The first conference was held on 1 - 3 December 1999 at Monash University, Melbourne Australia.

[online] http://www.csse.monash.edu.au/~iterate/ [Accessed 24 July 2000].

Generative Art

An international conference and exhibition on Generative Art held at the Politecnico di Milano University, Milan, Italy.

http://www.generativeart.com [Accessed 24 July 2000].


Generative Design Lab, Milan Polytechnic – Dep. Scienze del Territorio – Italy

An exhaustive resource inquiring into "The possibility to design the DNA code of the Artificial Ware, and so to directly generate an endless sequence of unique, complex and unpredictable 3D models of towns, architectures and objects."

http://progenlab3.dst.polimi.it [Sourced 24 July 2000]


Mandlebrot Music

Ever wanted to know how to play music composed by the Mandlebrot Set? Yo Kubota shows you how in the inspired, *Strange Music Archives*.

http://www.fin.ne.jp/~yokubota/mandele.shtml [Accessed 24 July 2000].