Who or What is Making the Music: Music Creation in a Machine Age

Tang-Chun Li
Faculty of Music, McGill University
Montreal, QC H3A 1E3 Canada
+1 514 398 4535
litc@music.mcgill.ca

ABSTRACT
This paper examines the music-creating process by exploring the roles of machine tools in today's music-making. Two working models of human composition and machine composition are proposed. We also examine the functional roles of tools in music-making, and the relationship among the tools, the tool builder, and the composer. Finally, music creation is discussed.

Keywords
Composition, music-making, music creation, machine composition

INTRODUCTION
One commonly accepted traditional view of social musical interaction (Sessions, 1950; Lansky, 1990) suggests that there are three tightly coupled entities: composer, performer, and listener. In his article "When Machines Make Music," however, Paul Lansky (1990) proposes that in today's social context, two more nodes should be added into this music-social interaction web: **instrument-builder,** and **sound-giver.**[1] The definition of Lansky's "instrument" is very general: it includes anything from a typical instrument like a piano to a computer system used in algorithmic composition. Indeed, today's electroacoustic composers have many more choices between compositional tools than any other time in human history. These tools have become one of the major forces in the making of music, academically and commercially. In most cases, they are used to create new sounds or to facilitate the compositional process. In some extreme cases, composers let the tools automatically create both the macro- and the micro- structures of the composition. For example, Robert Rowe's Cypher program (Rowe, 1991) can respond to musical input according to the setup of response features and patterns from the user;

David Cope's EMI (Cope, 1991) can generate music in the style of various composers by the program itself. In these extreme cases:

(1) Does the machine take over the act of music-making?

(2) If not, who or what is doing the act of composing?

(3) What are the relationships among the composer, the tools, and the music created?

(4) What is music-creating?

These questions are the central topics of this paper. This paper is organized as follows: First, I will define a working definition of composing music. Second, the roles of the tools in the composition process and the relationship between the tools, the tool builders, and the composer are examined. After clarifying the concept of music creating, we further explore the concept of machines making music and composing music. Finally, we briefly discuss artificial creativity issues.

WHAT IS COMPOSITION?
All the earlier proposed questions are deeply rooted in the concept of composition itself. To answer the questions, we must first ask: what is composition? According to the New Harvard Dictionary of Music, the definition of composition is "*the activity of creating a musical work; the work thus created.*" Larry Austin and Thomas Clark (1989) have a quasi-operational, semi-abstract definition: *"[composition] connotes putting music together, integrating the materials with skill, planning, and artful originality to satisfy the requirements of a particular musical genre."* To make it more operational, we define *the act of composing* as

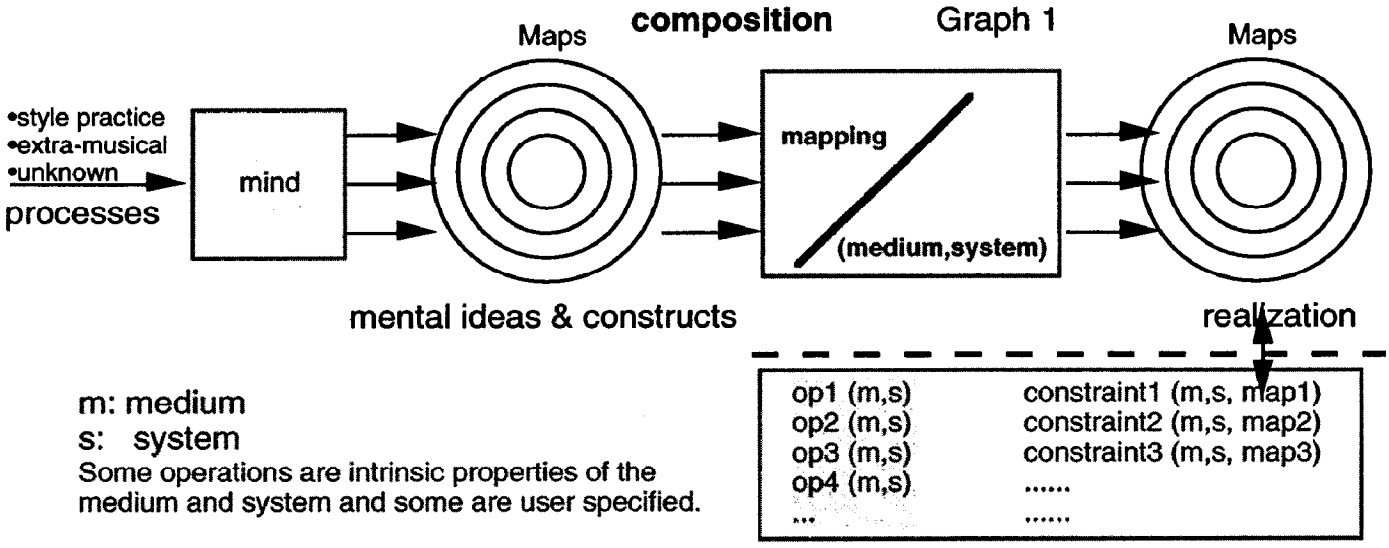
> **to externalize the ideas and constructs of the mind, or *mental maps*, by performing some operations on some type(s) of sonic medium and/or system to implement an instance of *realization maps*.**

The mental maps refer to key constructs and/or planning of the architecture of the musical work at various levels. They characterize the music from a high-level view. The medium can be the harmonic series, the chromatic scale, the pentatonic scale, the twelve tone series, a squeaking door sound, or the roaring of speeding cars on a highway during a quiet night. The realization maps refer to the transformed view of the

[1] Sound-giver refers to people who help to distribute the music of composers. This is the result of modern sound recording and distribution technology.

original constructs and planning through a mapping function of the medium/system. These detailed constructs and planning are the result of the constraints and properties of the medium/system. A composition, then, is an instance of the implementation of the realization maps. An implementation involves selecting operators and constraints for a verification process of accepting or rejecting the current instance.

All music must rely on some medium or system. In fact, *"[a]ll music promotes a world view in an implicit way since the choice of a particular system or language obliges the composer to adopt the vision mediated by it"* (Teipi 1995). Furthermore, there must exist some intrinsic properties and formal systems within the **medium/system** that regulate the composer's mental trajectory in music space. Finally, there are some abstract properties associated with the process of music-making and music itself. These properties describe the judgment of the "values" of the work, few of which are named by Austin and Clark: integration, artistic, and originality, all measured by the observer. The graph 1 shows the working model of composition processes.



m: medium
s: system
Some operations are intrinsic properties of the medium and system and some are user specified.

WHAT ARE TOOLS FOR IN COMPOSING IN A MACHINE AGE?

In a machine age like today, there are many methods and tools for creating interesting works, particularly in electroacoustic music. Usually, composers use these tools for two purposes:

A. Tools for the making of music:

(1) Tools to work on elementary composition materials and units, e.g., sound synthesis, and sampling.

(2) Tools to generate operators and their operation functions, e.g., combinatorial operations -- transposition, inverse, and rotation -- for the serialism, digital signal processing, and sound spatialization.

(3) Tools to edit scores, e.g., a score editor.

(4) Tools to construct structures and music decision-making routines of a composition, e.g., the SEE (Kunze and Taube, 1996) for the Common Music module construct, musical grammar, and high-level composition languages.

(5) Tools to build the generating processes of music-making, e.g., Cope's EMI and Rowe's Cypher.

Tools in Category 4 and category 5 are indeed implementations of abstractions of musical knowledge. Barry Traux says it well: *"automated, interactive, and process-oriented performance systems are all examples of how procedural knowledge ... can be integrated within a computer music system. Each extends or even redefines the compositional process, and each has the potential to create new musical languages."* (Truax 1986)

B. Tools to expand the composer's working memory and storage space:

While composing, a composer needs recording devices for the ideas, sounds, or scores generated. In traditional practice, a composer uses pen and paper to record scores and others. Today, many tools are used for recording the processes of music-making, including the sonic materials. There are also tools for computer representation of generated materials. Some examples include MIDI, sequencers, audio, and notation tools.

INTERACTION AMONG TOOLS, TOOL BUILDER, AND COMPOSERS

To understand the music creation process, it is necessary to understand the interaction modes among the tools, the tool builders, and the composers and, further, to identify the ownership of music creation. Today's compositional tools, especially computer

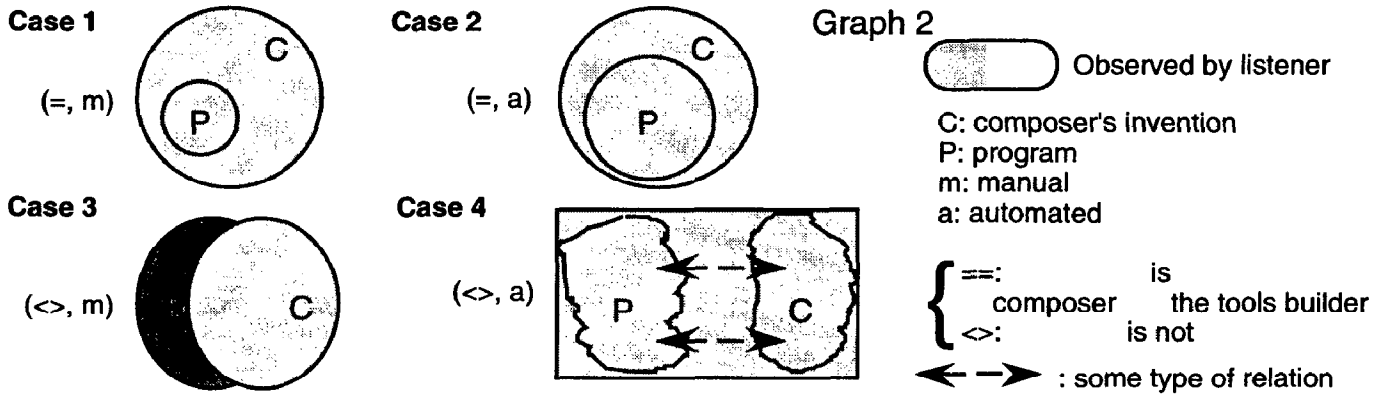
software, embody some personal views of what music is or how it should be. By using the tool, a composer then interacts with the musical space of the tool builder. There are at least two types of relationships among the tools, the tool builder, and the composer. One, the relationship between the composer and the tool builder: is the composer the tool builder? Two, how the tools interact with the composer: is it manually controlled by does the composer or the composer interact with automated systems? What or who dominates the process of music-making?

The first relationship raises the question of whose ideas are involved. If a tool is built by the composer, then it is one among many possible realizations of operators or constraints in his/her mental composition system. It serves as an aid for composition. On the other hand, when the tools are made by other people, they are instances of the creation of someone else's concept of compositional elements and organizations. The composer creates music by implementing his or her musical ideas on top of the framework offered by the tool designer. Herbert Brun (1969), Paul Lansky, and Berry Truax all share a similar observation. Lansky writes:

"Instrument design and construction now become a form of musical composition. ... Playing someone else's instruments becomes a form of playing someone else's composition. ...[T]here was probably little distinction in [Harry Partch's] mind between building an instrument and composing the music for it. ... [U]sing Csound, Music5, Cmix, M, Performer, Ovaltune, Vision, Texture, CMU Toolkit, is, to varying extents, adopting the musical vision of the designer." (Lansky 1990)

Truax, similarly, indicates that:

> *"Ultimately, a computer music composition reflects the musical knowledge embodied in both the software system that produced it and the mind of the composer who guided its realization. The interaction between these two bodies of knowledge is the essence of the creative musical process." (Truax, 1986)*



The second relationship addresses the degree of equality between the composer and tool builder during the interaction: it can be either master vs. assistant or two equal partners between a carbon-based improviser and a silicon-based improviser. When the tools are manually controlled by the composer, the tools are used to aid music-making, but the decision-making is done by the composer. When the tools function as an autonomic system, however, the composer responds to it as an equal partner or as a user. In the case of an equal partner relationship, if the composer is also the creator, then this is an interaction between the composer's musical mental maps and the cybernetic mirror of these maps. If the system is built by another tool creator, then two parties are interacting: the digital duplication of the tool creator's *mental maps* and the reacting system in the mind of the composer. On the other hand, if the composer is merely a user and the tools only contain universal (non-builder-specific) musical knowledge[2], then there is no difference if the composer is also the tool builder since the tools react indifferently and reflect universal, common musical knowledge. In this case, we view the composer and the tool builder as interactively unrelated even if they are the same person.

WHO OR WHAT IS MAKING THE MUSIC, THEN?

Now we can come back to our original question: who or what is making the music? By examining the four possible relationships among composer, tool builder, and tools, it is easy to see that only the case when both the composer is unrelated to the tool builder and the tools are autonomic, then there are some possibilities that the machine itself is making the music. For the other three cases, the composer is making the music. This can be explained by the graph 2.

The situation should be examined from a third party observer's view. The third party observer can only observe the composer's musical imagery in the first three cases. Only in the last case can the observer observe both the imagery of the composer and the program. Depending on who is in charge, the observer might hear something entirely different each time. If the program takes control of the processes of music-making,

[2] The universal musical knowledge here refers to the type of knowledge that is universally accepted within certain types of style practice. For example, Cope's SPEAC system (1991) is consistent with the Western tonal music theory.

the role of "composer" becomes more like an improviser or a game player. Under the circumstances, one would agree that the generated music is mainly the result of the program. Examples of this include the Band in a Box (PG Music Inc., 1998), the Harmonic Driving and Melody Easel in Tod Macover's Brain Opera (Paradiso, 1998), and Mozart's music dice game. However, can we say it is the machine that is making the music? In one view, making music refers to the abstraction of procedural generating of notes and materials. Whoever or whatever generates notes and materials is the music-maker. Therefore, the machine is the music-maker. In another view, it can be argued that the creator of the machine is the real music maker. The machine is simply a digital duplication of the realization maps in the mind of the creator.

One particular practice of composition, the algorithmic composition (Roads, 1996; Loy, 1989; ICMC, 1993), is strongly related to our discussion here. Regardless what techniques are used in the algorithmic composition, it follows the categorization described above. One interesting example is described in Martin Herman's position paper in the Second Panel on Algorithmic Music, ICMC 93 (ICMC, 93):

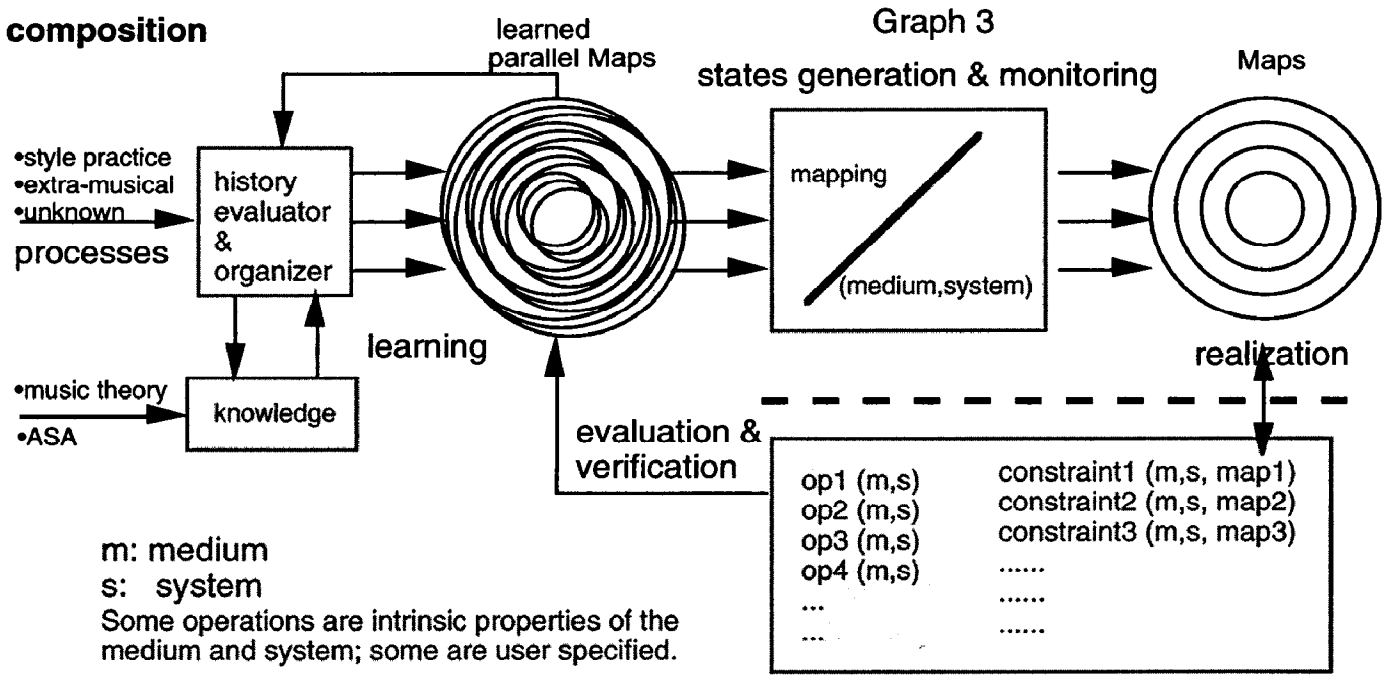
"The successful use of the dynamic models depends in large part upon the composer's ear.... What I hear is not the result of my projecting my own musical personality into the musical landscape, it is rather more like taking the first steps of a journey into a musical landscape that I could not have imagined before that fascinates and invites me. That landscape seems to me exist both in time and out of time: the composer is a visitor to a terrain that unfolds itself in time..."

The dynamic models used by Herman are completely autonomic. They lead the composer into an unexplored territory. However, it is the composer who decides how to use these dynamic models to map into musical space. The final result is based on the composer's own aesthetic judgment. In this situation, what we observe is the interaction between the dynamic models and the composer.

MACHINE MUSIC MAKING IS NOT MACHINE COMPOSING OR CREATING

Another example that poses interesting questions is the Experiments in Musical Intelligence by David Cope (1991, 1996). Cope presented three pieces of music in Bach's style in the AAAI 98 Conference: one by Bach, one by his program, EMI, and one by composer Steve Larson. These three pieces are very similar. Can we say that the machine composed the EMI piece in this case?

Before I answer this question, first I would like to modify my working model of composition. The adaptation of the traditional definition of composition would not work when we deal with machines. As shown in the graph 1, the first processing unit is mind. A machine can never have a mind by definition (see any dictionary). If a mind is a must, a machine can never compose music. So, does the composition process really need a mind? Or a mind-like process? Consider the following situation:



Imagine we have a Mozart machine -- a machine that is designed to compose in the style of Mozart through learning. For a human composer, by definition, *learning to compose* means that a student is given some knowledge (data) of music theories, musical practices, and lots of examples with the help of his/her innate capability of auditory scene analysis. By following this definition, the composing capability of a machine should come from its general learning faculty, assuming it has been provided with the auditory scene analysis capability. If a machine is given both the training data for its learning process by exposing many

positive examples and the expert advice as in the human student situation, and if the machine then succeeds in creating some "musical works" approved by the teacher, then we declare that this machine knows how to compose and the pieces generated by this machine are its compositions.

Following the definition above, most of the algorithmic composition systems use ad hoc knowledge directly from the builder. Therefore they do not qualify to be able to "compose" music. In a real composition machine, excluding the knowledge of music and auditory scene analysis, the learning scheme should be a general one that does not have goal-oriented ad hoc knowledge. Graph 3 is our modified model for machine composition.

As shown in the graph, the system records the history of its state generation and evaluation. Parallel maps are learned and used for various styles.

In the case of the EMI, we know the following as facts (Cope, 1991; Cope, 1996): (1) The music schema part of the EMI, the ATN grammar, is part of the well known knowledge in common practice of the Western tonal music. It is (considered to be) fed directly by the teacher. (2) The signature and texture part of the EMI, derived through pattern matching and statistic process, can be considered as learned through many positive examples. (3) The style dictionary is fed by the expert. (4) For a composer or user, the EMI controls the entirety of the generating process and reacts indifferently to all, including Cope. (5) The architecture of Cope's EMI is neither learned nor is it common musical knowledge. Specifically, the concepts of signature and texture and their usage for this problem are told directly by the expert. (6) The parameter tuning for the pattern recognition and statistics analysis is manually specified by the user (in this case, Cope) (Cope, 1996, pp. 90) through experiments and manual verification.

Fact 5 can be interpreted in either way depending on how ad hoc is the knowledge told by the expert. However, Fact 6 is truly ad hoc knowledge directly from the user. Therefore, the EMI is not a composing machine. The reason is that the success of the system depends on the intervention and verification of the user. Still, it can be called a music-making machine from some views.

Two other theories for recognizing the ownership of composing, creating, or other music activities are determined by intentionality (Searle, 1980), (Cross, 1993), or by the causal history of automatic, plastic generation-evaluation cycle (Elton, 1995). The EMI system does not exhibit either feature. Both theories are more general than the composition model described in this paper. Any machine exhibiting either feature would make music by itself. In this case, a composer serves no role. Could this artificial creativity happen in the near future? Although there are some interesting viewpoints (Stefik and Smoliar, ed., 1995) in the research community, in my view, creativity involves much more complex issues than claiming a machine is composing. The word of *creativity* itself needs to be specified in detail. Furthermore, creativity such as the P-creativity or H-creativity as defined in Boden (1991) requires clarification regarding its operational domains (who, whom, what, why, and how) in a musical social context and musical consensus. Unless these issues are addressed, artificial creativity is only theory on paper.

CONCLUSION

In this paper, we examine music creation through exploring the relationship between the tools and the composer in today's computer-based composition environment. Models for both human composition and machine composition are proposed. Tools are used either for the making of music or to extend the composer's working space and memory. They are the extensions of the builder's musical ideas. Depending on what types of tools are used, the composer interacts with the musical space of the builder in various degrees. In some cases, the tools dominate the process of generating music and the composer merely serves as a user or game player. In this situation, we claim it is the machine that is making music. We also make the distinction between music-making and composing music. Machine composing involves a knowledge database of both music theory and auditory scene analysis, a general learning unit, a set of positive examples, an advising expert, and an evaluation unit. The requirement for machine music-making is more relaxed. A program could use ad hoc strategies to make music, but it does not compose music.

ACKNOWLEDGMENTS

I thank Bruce Pennycook for his insightful comments and supports for letting me to do something that is outside of my main thesis work.

REFERENCES

1. Austin, L., and T. Clark. 1989. *Learning to Compose.* Wm. C. Brown Publishers, Dubuque, Iowa.
2. Boden, M. A. 1991. *The Creative Mind: Myths and Mechanisms.* Basic Books, New York.
3. Brun, H. 1969. Infraudibles. In *Music by Computers,* H. Von Foerster and J. Beauchamp, ed. New York: John Wiley & Sons.
4. Cope, D. 1991. *Computers and Musical Style.* A-R Editions, Madison, Wisconsin.
5. Cope, D. 1996. *Experiments in Musical Intelligence.* A-R Editions, Madison, Wisconsin.
6. Cross, I. 1993. The Chinese music box. *Interface,* vol. 22(1993), pp. 165-172.
7. Eaton, M. 1995. Artificial creativity: enculturing computers. *Leonardo,* vol. 28, no. 3, pp. 207-213.
8. Kunze, T., and H. Taube. 1996. SEE -- A structure event editor: visualizing compositional data in Common Music. In *Proceedings: ICMC 1997.*
9. ICMC. 1993. Positional papers for the Second Panel on Algorithmic Music. Proceeding: *ICMC 1993.*
10. Lansky, P. 1990. A view from the bus: when machines make music. *Perspectives of New Music,* Vol. 28, Summer 1990, pp. 102-109.

11. Laske, O. 1992. The humanities as sciences of the artificial. *Interface*, vol. 21, pp. 239-255.

12. Loy, 1989. Composing with computers -- a survey of some computational formalisms and music programming languages. *Current Directions in Computer Music Research.* MIT Press, Cambridge, Mass.

13. Paradiso, J. A. 1998. New instruments and gestural sensors for musical interaction and performance. http://physics.www.media.mit.edu/publications/papers/98.3.JNMR_Brain_Opera.pdf.

14. PG Music Inc. 1998. Band in A Box.

15. Roads, C. 1996. Algorithmic composition systems and Representations and strategies for algorithmic composition. *Computer Music Tutorial.* MIT Press, Cambridge, Mass.

Creativity & Cognition 99 Loughborough UK

16. Rowe, R. 1993. *Interactive Music System.* The MIT Press, Cambridge, Mass.

17. Searle, J. R. 1980. Minds, brains, and programs. *Behavioral and Brain Sciences,* 3 (1980), pp. 473-497.

18. Sessions, R. 1950.

19. Stefik, M., and S. Smoliar, ed. 1995. "The Creative Mind: Myths and Mechanisms": six reviews and a response. *Artificial Intelligence,* 79 (1995) 65-182.

20. Tipei, S. 1995. For an intelligent use of computers in music composition. Proceedings: *ICMC 1995.*

21. Truax, B. 1986. Computer music language design and the composing process. In The *Language of Electroacoustic Music*, S. Emmerson, Ed. Macmillan Press Ltd.