INNOVATION, INTERACTION, EXPERIENCE AND IMAGINATION IN COMPUTER MUSIC EDUCATION

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ABSTRACT

This paper presents the “Electronic Music and Sound Design” project, which explores innovative solutions for teaching computer music, especially as regards the theory and practice of sound synthesis, signal processing and sound design. The project uses integrated and interactive self-learning environments, leading the user on a journey from novice to expert thanks to the interaction between theory and practice, experience and imagination. A number of activities (replacing parts of algorithms, completing unfinished algorithms, correcting algorithms with bugs, interactive sound-building exercises and reverse engineering) help lead the user to what Joel Chadabe terms ‘predictive knowledge’ — the ability to intuit what will happen to a sound before you take a specific action to modify it. The authors’ approach involves interactions between the perception of sounds and the knowledge and skills deriving from studying the theory and performing the practical activities, as well as fostering the user’s own individual creativity.

1. INTRODUCTION

The “Electronic Music and Sound Design” project presents a series of innovative solutions for computer music education and training in both the theory and the practice of sound synthesis, signal processing and sound design. This project, based on the Max/MSP software, consists of three books and interactive multimedia environments, which the authors have developed over the course of the last 5 years. The project combines pedagogical context-based paradigms with integrated and interactive self-learning environments, taking the user on a road of exploration based on the interaction between theory and practice, experience and imagination.

2. FROM CONTEXT-FREE RULES TO INTUITION AND IMAGINATION

The bibliography of electronic music education is very limited and a universal consensus regarding an appropriate teaching method has not been developed. We adopted various methodological criteria, sometimes taking ideas from other disciplines (such as foreign language education), in order to encoura-
learning a computer programming language: a student can understand how algorithms work without being able to build them from scratch. We encourage the learner to find different ways to replace parts of algorithms, complete unfinished algorithms, analyze and correct algorithms with bugs, and practice reverse engineering (in which the reader listens to a sound and then tries to invent an algorithm to create a similar sound). Here is an example of activity:

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This patch is incomplete. There are four objects that can be found on the right that have no connections. Move these into functional positions based on the following hint: the output of the patch "random-minmax" is a message, not a signal, while groove- accepts only signals, used as a stream of multiplication factors, on its inlet. How can we resolve this problem? For what purpose can the ~ object be used? What signal should the number- object monitor? What does sig- do? Complete the patch and experiment with various changes to minimum and maximum values, using both positive and negative numbers. (Of course, the minimum value should always be less than the maximum value!)" [6]
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These activities (featured in the books and in the online patches and interactive material) pose problems to which users are encouraged to find their own solutions. When learning a foreign language, students are given replacement exercises (e.g. "I wish I could go"), correction exercises (e.g. "correct the following phrase: I want to went home"), and sentences to be completed (e.g. "I’d like to... home"). The student must intensively practice similar activities, as well as listening and conversation exercises, in order to avoid an excessively passive and "bookish" approach to learning. Our approach, likewise, involves interactions between the perception of sounds and the knowledge and skills deriving from reading the book and doing the practical activities, but it also integrates and complements all these factors with the user’s own creativity. The cycle of training in the martial arts known as Shu Ha Ri dictates that at first the student must copy the techniques exactly as s/he is taught. In the next stage the student assimilates and deepens his/her theoretical and experiential knowledge. In the final stage the practitioner innovates and offer his/her own original interpretations and thoughts. We believe it is much more effective to combine all these three stages from the very beginning. We intend for our course in electronic music and sound design to lead towards a creative use of technology, as much as possible in conformity with the original, etymological meaning of the word education. In fact it comes from the Latin educare which means to lead out; in the maieutic sense of drawing something forth from learners and giving them the means to find their own “voice”. Emmerson’s idea about composition and pedagogy is very similar:

“It is my contention that composition has moved to too great a degree towards ‘objective’ or ‘knowledge-based’ criteria and has forgotten the role of shared ‘subjective’ experience and exploration.”[9]

### 3. INNOVATION: COMBINING THEORETICAL KNOWLEDGE AND EXPERIENTIAL LEARNING IN THE SAME SYSTEM

The theory in our books and interactive material is conceived and presented in such a way that the user alternates its study with practical exercises as s/he progresses. The planning of the course takes account of the learning process and the experience that the student progressively acquires in all areas (theoretical, analytical, practical, etc.). The student therefore always learns within a creative and motivating context, always in contact with the production and perception of sound and without ever having to tackle lengthy theoretical discourses or explanations of the mechanisms of the software. The interaction between perception and knowledge, and the interchange between deductive, inductive and creative processes is continuous. There are some similarities between this kind of learning approach and learning to play a musical instrument, especially regarding the sonic feedback the musicians continuously receive in the “search for the right sound” guided by their technique and intuition, which leads them to gradually improve their performance using perceptual data. Learning to play an instrument and learning sound design are very far from a linear pedagogical process focused on merely providing a reader with objective facts. Our method is intended as a holistic and integrated process of research and discovery. That is one of the reasons why we started to look at foreign language teaching as a source of information about context-based, interactive learning. We found that many activities and ideas in that specific field can be usefully translated into methods for learning a programming language involving sound production and manipulation.

“In my view, the manipulation aspect of learning about sound is critically important. It helps lead you to what Joel Chadabe terms “predictive knowledge” – the ability to intuit what will
happen to a sound before you take an action to change it. We all have some level of predictive knowledge. For example, most of us know that by turning a volume knob clockwise, the sound coming from our amplifier will get louder. Once we enter the realm of digital sound synthesis, things quickly get more complicated than a volume knob, and we need the first-hand experience of manipulation and perception in order to deepen our predictive knowledge.

However, to educate ourselves fully about digitally produced sound, we need more than predictive knowledge. We need to know why our manipulations make the perceptual changes we experience. This theoretical knowledge reinforces our intuitive experiential knowledge, and at the same time, our experience gives perceptual meaning to theoretical explanations.” [13]

But what kind of experience and what type of theory are involved in our method? As regards the difference between teaching to scientific researchers or to musicians/sound designers Giuseppe Di Giugno once pointed out that for the former group “the real thing” is the formula, or the algorithm and making sounds by the variation of parameters is just an exercise. For musicians and sound designers making sounds is “the real thing” while learning the algorithm is a means to reach their goals. As most of us are aware this boundary between the two approaches is becoming less and less clear. Our system is aimed primarily at musicians and sound designers and because of that we have tried to create examples which “sound good” and are stimulating for the practice of composing, so our patches are not just intended as examples to illustrate the theory. Practical experience combined with imagination and perception often challenges the theory and expands its boundaries. In some cases the standard theory is unable to explain some of the reasons why the “tips and tricks” that are commonly used in sound design work so well. Thus we sometimes had to add some explanations to the theoretical sections, as in the case of multiple harmonics, filters, and the “grey areas” between the harmonicity and non-harmonicity of sounds. In this latter issue of harmonic/non-harmonic sounds and their connection to the concept of periodicity/aperiodicity we tried to extend the theoretical concepts and combine them with perceptual events.

“If the lowest component in a harmonic sound is missing, but the immediately succeeding components are present, the sound will be heard as having a pitch equal to the missing fundamental. If, in addition to the fundamental, we start to remove other lower harmonics, we hear the gradual loss of its harmonicity, because at some point, our brain is no longer able to reconstruct the fundamental. A sound thus obtained is non-harmonic, but at the same time periodic, because its period is still the inverse of the frequency of its “virtual” fundamental. A non-harmonic sound composed of partials at 100, 205, 290, 425, and 460 hertz, for example, has a fundamental of 5 Hz, and is therefore a periodic sound that repeats 5 times per second (although it is not possible to hear this fundamental). We’ve seen that you can have a periodic sound that has no definite pitch. On the other hand, is it possible to have a non-periodic sound that does have a definite pitch? Certainly. It is enough to have components whose frequencies are close to being integral multiples of some audible fundamental. The partials 110, 220.009, 329.999, 439.991, and 550.007 hertz, for example can be heard unequivocally as an A, even though their period doesn’t correspond to the perceived fundamental, but rather to the greatest common divisor of the components, which is 0.001 hertz. To be precise about this, the period of this waveform is 1000 seconds, and a sound with a period as long as this is psycho-acoustically equivalent to a non-periodic sound.” [6]

4. INTERACTION BEFORE PRACTICE

Clarke points out that:

“Simply reading a book or attending a lecture can lead to study that is remote from the sound that is the key element in the discipline. Lecturers may play musical examples and written texts may direct students to scores or CDs, but for many students this is not as stimulating as experiencing the music for themselves, especially engaging with it interactively.”[7]

The interactive examples we provide in our project constitute a bridge between the study of the theory and the interaction with perception. The path laid out in the theoretical sections of our books is accompanied by numerous interactive examples, which are available on the website at www.virtual-sound.com/emasad. Thanks to these examples, the user can immediately hear the sounds being discussed, as well as understand their design, without necessarily having to spend time in programming them. In this way, the study of the theory is immediately connected to the concrete experience of sounds. Our objective is to integrate the student’s understanding and experience of sound design and electronic music. This principle is the basis for all three volumes, as well as for future online materials that will be used to update, broaden, and clarify the existing text.

The Interactive Examples Software Application contains a set of examples for each theory chapter. A typical example consists of a custom interface allowing one to choose between a certain number of presets (pre-selected configurations of parameters) illustrating a particular technique of synthesis or sound processing.

A spectroscope, a sonogram, and an oscilloscope appear at the bottom of the window, and can be used to analyze the spectral content and the waveform of the sounds produced by the example. Generally the first presets listed for each technique are “frozen”, i.e. the user cannot manipulate the parameters, but can only hear and analyze the sound with the help of the sonogram, spectroscope and oscilloscope. The last presets for each set of examples are free configurations in which the user can vary and manipulate the parameters and experiment with a particular technique.
The users of our system can start from scratch and program with Max/MSP and apply their knowledge and skills towards creating the sounds they want. The users learn the theory while also learning to complete and holistic nature of the whole project. Thus the users learn the theory while also learning to program with Max/MSP and apply their knowledge and skills towards creating the sounds they want. The users of our system can start from scratch and end up dealing with physical modeling, but in the process they will have acquired a method of critical thinking and an experience that will also be useful for approaching and employing different computer music languages (including those of the future) with an open and flexible mind.

5. CONCLUSIONS

It is perhaps not so important whether book and project such as ours is physical or virtual. It is the thought that has gone into it that really counts, as well as the effective integration with the software materials (in fact we have supplemented the text with hundreds of patches, interactive examples and useful activities.)

The goal of our teaching system is to create a fully integrated pathway of learning. It is not just a set of information on specific kinds of sound synthesis, an informative Max/MSP manual or a collection of heterogeneous materials; its real value is the complete and holistic nature of the whole project. Thus the users learn the theory while also learning to program with Max/MSP and apply their knowledge and skills towards creating the sounds they want. The users of our system can start from scratch and end up dealing with physical modeling, but in the process they will have acquired a method of critical thinking and an experience that will also be useful for approaching and employing different computer music languages (including those of the future) with an open and flexible mind.

6. REFERENCES


