THE UPIC AND ITS DESCENDANTS :
DRAWING SOUND 2012

Rodolphe Bourotte

Centre Iannis Xenakis, rodolphe.bourotte@centre-iannis-xenakis.org

In Makis Solomos, (ed.), Proceedings of the international Symposium *Xenakis. La musique électroacoustique / Xenakis. The electroacoustic music* (université Paris 8, May 2012).

ABSTRACT

The UPIC, Unité Polyagogique Informatique du CEMAMu, was created by Iannis Xenakis in 1977. This machine consisted in a mini-computer, an audio interface, a monitor displaying parameter values, a architect-sized graphic tablet allowing for a precise digitization of the drawings made, and an electromagnetic pen. Its purpose was to ease access to a new way of composing music : by drawing. The motivations for a tool such as UPIC are deeply grounded in scientific and musical traditions, as these two disciplines have always been interweaved. Still pursuing one of the main ideas behind this tool, i.e. Its democratization, the UPIC software was ported on PCs in the 90s, and in 2001 was freed from the need for a specialized sound interface. Since then and following the closure of the CEMAMu (Centre d'Etudes en Mathématiques et Automatiques Musicales, dedicated to research and development of the UPIC), ten years of world wide software innovations have occured. So it might seeem of interest to overview the tools one disposes of today, when thinking graphically about sound. Then, once having made the constatation that Xenakis ideas were generally implemented in separate, independent programs, we will devise an integration of two of them: sieves and stochastic sound, into a single graphical editor.

INTRODUCTION

The first version of UPIC dates back to 1977. Culturally, the society was at that time feeling the firstfruits of a drastic evolution of our capabilities to interface humans and machines. The magnitude of both human and hardware investment at that time for such a project gives an idea of the significance of the challenge. The task was to put together a computer, an audio digital-to-analogue interface, a monitor and a graphic tablet. Once achieved, the system benefitted from various improvements, among which porting on small PCs, adding a real-time feature, sequencing abilities, register expansion... which led to the last version in 2001, the UPIX software, which can run on any Windows PC, independent of the audio hardware. The CEMAMu, in charge of the development of the software, was closed subsequent to Xenakis's death in 2001. The French Ministry of Culture made the decision to allocate a budget for Iannix, a fresh-from-start project initiated by La Kitchen and Thierry Coduys.

Iannix eventually allowed for new ways of drawing sound events. Nevertheless, while instigating some new and very valuable concepts, Iannix did not keep tight links with some previous features of the UPIC; namely, the most mentionable may be the ease of use given by the integration of sound synthesis and drawing in a single real-time tool. Yet this point remains questionable in some respect, if one maintains the foresight of the way software evolves; i.e. towards easier communication between one and another. But still at this time, the question of immediacy remains. As Henning Lohner has underlined, “The point must be stressed that it is the objective of UPIC to have the computer aid your own two hands at drawing, to aid manual construction. With this in mind, automatic sound creation or processing devices (such as rhythm generators and the like) should be considered more adjuncts to the basic system. (You could construct many of these effects directly on the UPIC, but the UPIC is not optimized for them.) All automatic functions are used principally to aid manual input, and not vice-versa." (Lohner, 1986)

THE EXPERIENCE OF DRAWING

The act of drawing, in itself, involves multiple natural abilities. It requires the help of sight as well as touch (and in our case, also hearing) senses. Therefore, when drawing sound matter, for the complete cognitive experience to be acomplished properly, arise two topics arise: accuracy and timing. Accuracy in the interpretation of gestures should not be neglected. The onscreen representation of a hand-made drawing should be faithful, and an immediate sounding and visual feedback should be obtained by a user's action.

Aspects such as the accuracy of drawing and a real-time sounding possibility according to the position of the pointer, seem however to be a key factor. Developers in a wide range of software technologies focus their preoccupations on user interface feedback. For instance Andrea Agostini and Daniele Ghisi, who created the bach library of externals, which integrate a sequencer with musical notation abilities inside Max/MSP, say: "There is no deep reason why symbolic processing should not be performed in real-time, the only reason being what we could label a 'technological anachronism.' In fact, advanced symbolic computation and musical representation can easily become very costly in terms of processing power, and personal computers could not stand its computational weight until a few years ago. This situation has established a traditional separation that, although still lingering on, is no longer justified, since interactivity is an essential performative aspect of the musical discovery process, allowing any input gesture to immediately affect a given score." (Agostini and Ghisi, 2012) While staying in the musical domain, we can also cite Jean-Baptiste Thiebault, who conducted researches on gesture, space and music: "The initial stages of creative design often involve sketching. Electroacoustic composition is no exception to this. Paradoxically, the technologies that enable this form of composition provide little support for the sketching process *itself.*" (Thiebault, 2008)

Back to Iannix, one improvement that was undoubtedly made about its drawing interface, was to introduce vector-based drawing. This key feature renders feasible the drawing of curves of whichever size we like, from micro to macro-time. Figures 1 and 2 below show that feature which was not available as recently as March 2012, proof that the project is well alive. A path is created in Inkscape, an open source software for the creation of vector-based graphics, and then imported as a .svg in Iannix:

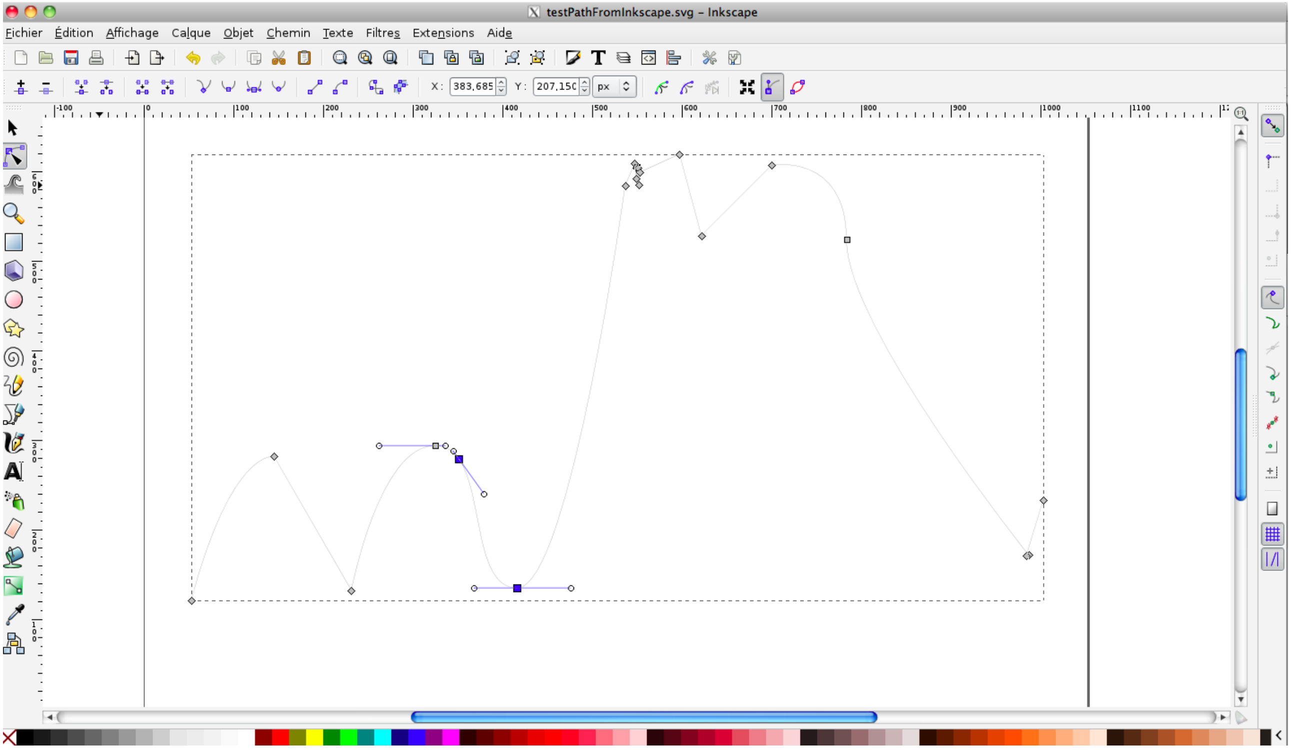


Figure 1: Creation of a path in Inkscape.

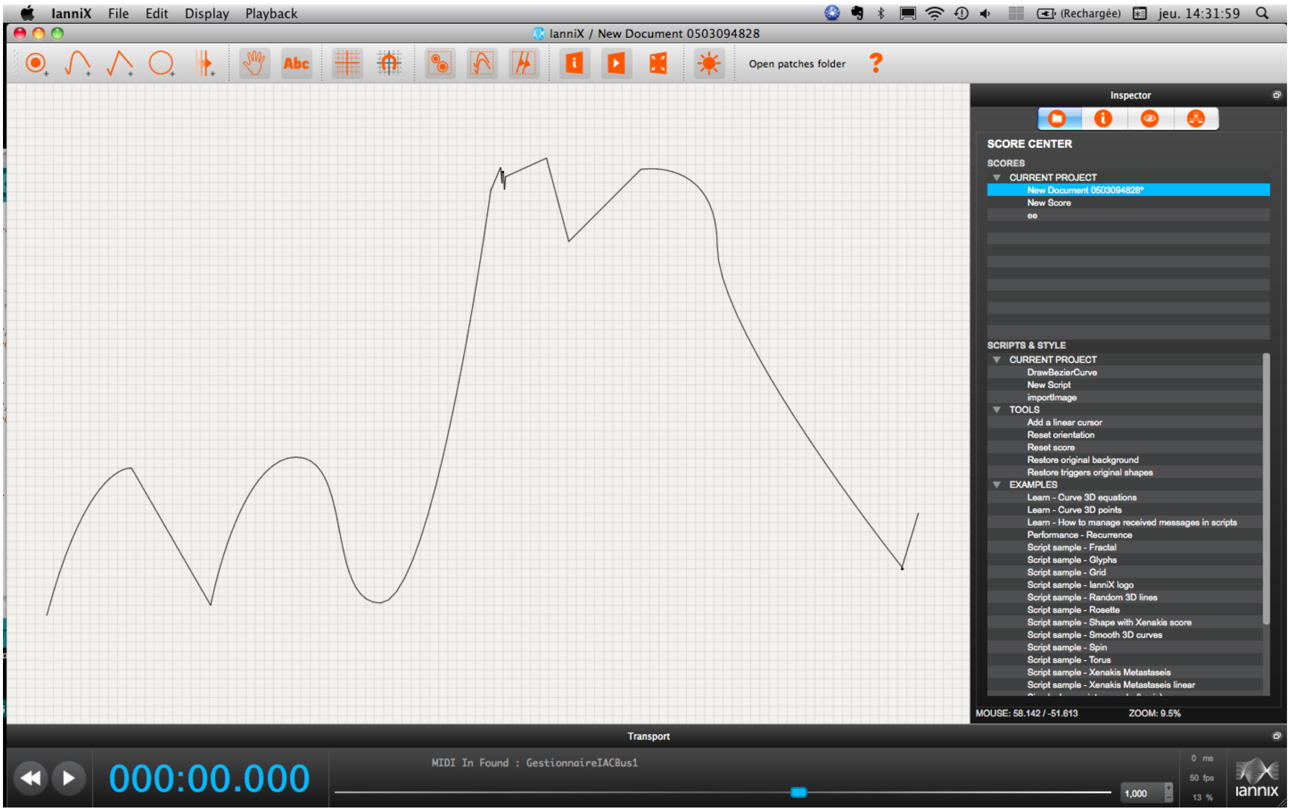


Figure 2: Importation, in Iannix, of the created .svg file. (".svg" stands for scalable vector graphics.)

As a reminder, Figure 3 below is a screen capture, in Inkscape, of a highly zoomed image, with at its left the vectorial representation and at its right, the non-vectorial copy of itself:

Figure 3: Vectorial vs. Bitmap representation

This shows that density (or color), can also be applied a vector-based representation. Such a representation will prove useful for the purpose of probabilistic drawing, as will be shown in the following.

PROBABILISTIC DRAWING

Peter Hoffmann worked on the first real-time Gendyn implementation, allowing at last for Dynamic Stochastic Synthesis to be a tangible tool. He states: " It is curious how the two inventions of Xenakis', although conceived of as complementary (fixed, hand- drawn UPIC waveforms vs. dynamic, ever changing GENDYN ones) can both fulfill Xenakis' lifelong dream of an "Automatic Music", in spite of the fact that Xenakis himself was seemingly not aware of this being possible with his UPIC system." (Hoffmann, 2009) Indeed, UPIC and Gendyn never had a chance to be integrated into a single tool. Even if coming from previous calculations, the Achorripsis matrix did held graphic aspects. What if this kind of matrix could be extended to the continuous domain? Why not allow for drawing, as intuitively as parts of *Mycenae Alpha* seem to have been drawn, and not only deterministic events? The same holds true for probabilistic events as well...

The definition of a probabilistic drawing is: a drawing where the darkness of a position represents its likeliness to occur. This kind of drawing in shades of gray, provided that it describes only one value over time, saves us the need for a 3D representation. The ProbaPainter program was designed to support probabilistic drawing, we can expect that from its development stage: a simple proof of concept. It has been developed within the Max/MSP environment, and used as the main tool for the realization of my piece "110110", premiered in 2012 at the ZKM.[1] The abscissae in ProbaPainter are assigned to time as a default configuration. Each vertical slice of the drawing at a given abscissa, is hence the probability distribution for the ordinate. When we hit "Calc Prob", each slice of this distribution is integrated and normalized. When in performance mode, ProbaPainter will output a random number according to the probability distribution found at the abscissa given in its input. This operation will be performed on every interval of time specified by "trigger period" (in samples). The resolution in this implementation is limited to a Width*Height of 1000*256 pixels.

[1] The synthesis engine itself consisted in a personal Max/MSP external, gendynix~, that implements Dynamic Stochastic Synthesis.

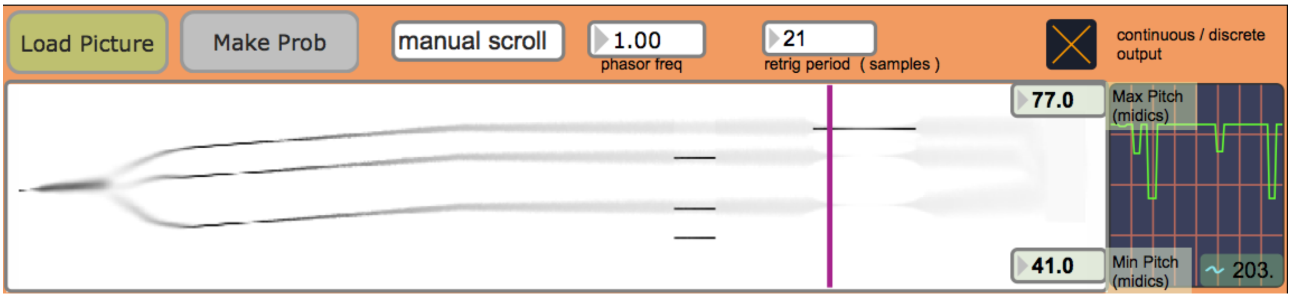
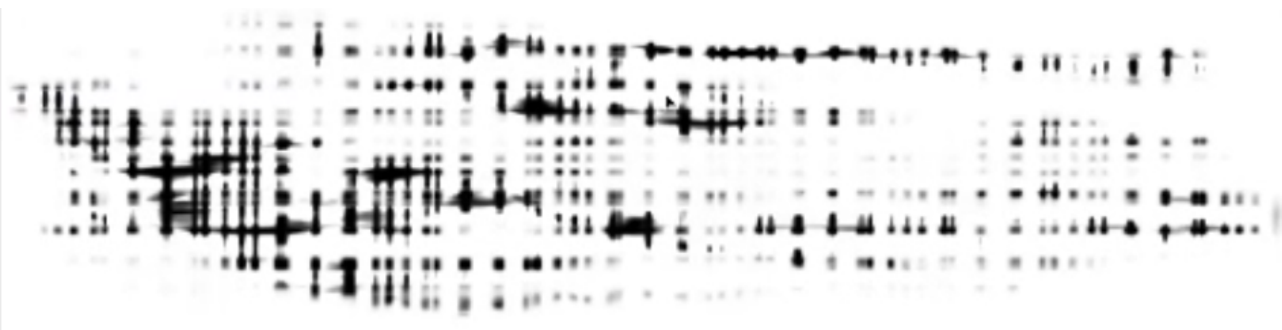


Figure 4: Screenshot of ProbaPainter

SIEVES

Christopher Ariza has made a very complete implementation of Xenakis's sieve theory, using Python and Csound. (Ariza, 2009 and AthenaCL, in the software links). Among diverse ideas that provide fruitful links between sieves and sound synthesis, Ariza proposes to use them for "waveform segment synthesis". This idea, suggested by Xenakis and reinstated by Curtis Roads (Roads, 2002), furthers the integration of the theories presented by Xenakis in his book "Formalized Music" (Xenakis, 1992). But, for people who are more inclined to drawing, the sieve theory inevitably calls upon the visual approach. This means that, once more, depending on the natural tendencies a composer is inclined to, there is no reason why s/he should not be able to design sieves by drawing them rather than by writing code. Furthermore, the ability for a sieve to be modified or mutated over time can also be easily most addressed by drawing. We can consider a whole gamut of graphical transformations allowing for continuous, gradual changes between one sieve and another. Here is an example in Photoshop showing what manipulating sieves looks like graphically. This example shows also that from a single image and two sieves (one vertical and one horizontal), a whole world opens up for exploration:



Figures 5 & 6: applying a 2-dimensional sieve to a probability distribution, using layers in Photoshop.

SPACE

As we have seen, for an improved version of ProbaPainter to exist, there would be an obvious need for a 3D internal vector-based representation of the drawing, so that no influence on continuity would be felt from any change of scale whether it be in space or time. Thus, our observation about about space, time and probability, naturally leads us to the idea that the very same principle of probabilistic drawing could be applied as well to the spatial distribution of acoustical energy. It would eventually call for some added dimensions, but somes study cases could find a workaround for these dimensions in excess. For instance consider a simple longitudinal distribution inside a tube. Another approach would be to get rid of the time, just focusing on the static distribution in a plane. Starting from this, we could model an imaginary acoustical source. While its propagation in a virtual space could be simulated using physical laws, its very emission would come from arbitrary, abstract representations. What is music, if not real-time architecture ? What do we feel when playing music, if not an extreme sensation of power over space ? When one emits a sound, s/he is in the matter of an instant, affirming control on the energy carried by molecules of matter surrounding the listener. This control far exceeds the limits of what is actually happening in terms of movement of solid objects. I am speaking about air here. Music organizes patterns of energy in space, a space comparable in size to buildings. Music lets you magically sculpt volumes hundreds of times bigger than your own body.

MISCELLANEOUS REMARKS

How can we treat a probabilistic drawing ? We see that three kinds of variables are involved: discrete, continuous, aleatoric. Hence we understand how these variables interact. Several random trials over a continuous distribution can issue a succession of discrete values, simply because they are trials, which means discrete events. As a matter of fact, our first attempt to deal with this three-fold nature of variables dates back to 2001, when creating the guidelines for building a sequencer called lafCADio. Extraordinary possibilities could stem from the unification of deterministic and probabilistic representation of events. We must consider the current existing models as still being incomplete. What needs to be worked out is a seamless manipulation of the three kinds of variables: continuous with deterministic curves, discrete either in abscissae or in ordinates, and aleatoric with colored or 3D representation taking into account darkness (or density) of the drawing.

CONCLUSION: A TWO-FOLD DEVELOPMENT CONJECTURE

An important future can be foreseen for two aspects of drawing sound. One concerns the most basic aspects of the drawing experience, that can be seen as a continuous improvement of what was implemented in the UPIC. The other consists of incorporating new ideas. Since its release and to this day, many cross-breeding ideas are born from Xenakis's book “Formalized Music”.

UPIC remains the only tool, twenty years later, to combine a synthesis engine with an accurate drawing tool, allowing for immediate feedback. It is therefore essential that the UPIC experience continues. Tools remain to be developed in order to pursue the idea that drawing is an important part of the music composition workflow.

REFERENCES

Agostini, Andrea and Ghisi, Daniele (2012), « Gestures, events and symbols in the Bach environment. Journées d'Informatique Musicale proceedings (JIM 2012), Mons (Belgium), p. 247-255.

Ariza, Christopher (2009), « Sonifying Sieves: Synthesis and Signal Processing Applications of the Xenakis Sieve with Python and CSound. », ICMC Montreal 2009, ICMA., p. 7.

Lohner, Henning (1986), « The UPIC System: A User's Report », Computer Music Journal vol.10 n°4, p. 42-49.

Hoffman, Peter (2009), « Music out of nothing? A rigorous approach to algorithmic composition by Iannis Xenakis » PhD Thesis. Technical University Berlin, p. 125.

Roads, Curtis (2002), *Microsound*, The MIT Press (Cambridge, MA), p. 30-31.

Thiebault, J-B. 2008. « Drawing electroacoustic music ». *Proceedings of international Computer Music Conference* (ICMC 2008), University of London, p. 1.

Xenakis, Iannis (1992), *Formalized Music* (translations Christopher Butchers, G. H. Hopkins, John Challifour; new edition augmented by Sharon Kanach), Stuyvesant (New York), Pendragon Press, 1992.

Xenakis, Iannis (1990), « Sieves. », *Perspectives of New Music* n°28, p. 58-78.

Xenakis Matters, (Hillsdale: Pendragon Press, 2012).

SOFTWARE LINKS

- "AthenaCL", http://www.flexatone.org/article/athenaCLMain.
- "Iannix", http://www.iannix.org/.
- "Max/MSP", http://cycling74.com/.
- "ProbaPainter", http://www.rodolphebourotte.info/code/ProbaPainterDemo1.1.zip.