ELEMENTARIDADES
A Composition based on Elementary Particle Model and Expressive Motion

Adolfo Maia Jr
Interdisciplinary Nucleus for Sound Studies (NICS)
Applied Mathematics Department (IMECC)

Raul do Valle
Interdisciplinary Nucleus for Sound Studies (NICS)
Music Department (DM/IA)

Jônatas Manzolli
Interdisciplinary Nucleus for Sound Studies (NICS)
Music Department (DM/IA)

Joana Lopes
Interdisciplinary Nucleus for Sound Studies (NICS)
Scenic Arts Department (DAC/GITD)

State University of Campinas (UNICAMP)
Campinas, SP, Brazil
13081-970
BRAZIL
{adolfo, raul, jonatas, joana}@nics.unicamp.br

ABSTRACT

We describe the creation of an interdisciplinary piece named ELEMENTARIDADES based on the following frameworks: Algorithmic Composition, the Rudolf Laban's Theory of Expressive Motion and the physical model of elementary particles of matter. The sound environment of ELEMENTARIDADES was constructed via concepts of Sound Functors and Categories. The Interdisciplinary Group for Theatre and Dance (GITD - UNICAMP) created the choreography and the music was composed using algorithmic composition software developed at the Interdisciplinary Nucleus for Sound Communications (NICS - UNICAMP).

1. INTRODUCTION AND RESUME OF THE PHYSICAL MODEL

It is well known that crossing of different areas of human knowledge leads to fertilisation and creativity. In this way new structures and methods can be developed, enlarging frontiers. An interesting example of creative crossing between art and science through applications of the technology and abstract mathematics as well. Computer Music is a very good example of this kind of crossing. So, it is not difficult to guess that this crossed fertilisation is now invading the world of dance and theatre empowering new ways to create and express artistic manifestations. In order to connect the different fields we need to construct an abstract representation of each one of them, which should be suitable to a theoretical analysis. In the piece ELEMENTARIDADES, this was provided by three systems: the Standard Model of the fundamental structures of the matter in the universe, a choreographic system based on Rudolf Von Laban model of the analysis of motion, and a sound environment, by using algorithmic compositional tools developed at NICS (UNICAMP). All the three systems listed above share the aspect that they are *reducionists* in the sense that they try to get the minimal parts of information and construct complex structures out of them. Once obtained these atoms of information of each field, a mapping between their fundamental blocks is defined. ELEMENTARIDADES is the result of this correspondence. The piece is divided in 5 sections, namely: **Baryons**, **Leptons**, **Gyros**, **Chaos** and **Cosmogenesis**. Sections baryons and leptons describe some of the modern view of the fundamental particles, which form most part of visible matter in the universe. **Baryons** (heavy in Greek)

names a family of particles in which is included the most common ones, such as the very known protons and neutrons.
The electron is part of a family of particles named **Leptons** (meaning *light* particles in Greek). There exist six leptons: the very known electron, the muon and the tau and their respective neutrinos namely, electron neutrino, muon neutrino and tau neutrino.
The section **Gyros** describe one the fundamental aspects of quantum systems, namely, the concept of spin, which means that elementary particles have an intrinsic angular momentum, a kind of elementary rotation, named simply spin (Gyros in Greek).
Another important fact about matter is that there is no rest at all in the universe. At microscopic level, Quantum Mechanics shows that there exist always a residual motion of matter due to so called vacuum fluctuations. At macroscopic level the universe is in constant expansion and also there exists an apparent random distribution of galaxies and clusters of galaxies at very large scales of distance in the universe. Instead using white noise to describe these aspects of matter in sounds, ELEMENTARIDADES present them as short percussive blocks of sound but randomly distributed in the section **Chaos**.
The Big-Bang model in which the universe came to existence as a by-product of a very huge explosion from which all matter in the universe was created describes the Modern view of cosmology. So, we ended the piece with sound representation of the creation of the universe in the section **Cosmogenesis**. Sound elements of the other sections are presented in Cosmogenesis in order to show the coherence and correlation between all parts of the model.

2. THE LABANIAN MODEL OF EXPRESSIVE MOTION

The idea here is to transport some properties describing the elementary particles to motion of dancers. In ELEMENTARIDADES a collection of elementary motions was created in accordance to Rudolf Von Laban's Theory of Expressive Motion (Laban, 1999). Now we can put them together in a time sequence given raise to several possibilities of articulation and combinations. Thus, this process can generate body motions of great complexity, using all corporal vectors, which represent elementary particle motions such as we suppose there exist, for example, inside protons and neutrons. Therefore it is possible to analyse and create a Labanian notation for this piece which could be used as a case study for classes in choreography. Laban's Theory of expressive Motion as well his useful notation are out of the scope of this paper, but we show below the main diagram used in Laban's notation (Table of Efforts) for qualitative description of the motion. Any human motion has a representation as a sequence of sub-diagrams of the **Figure 1**.

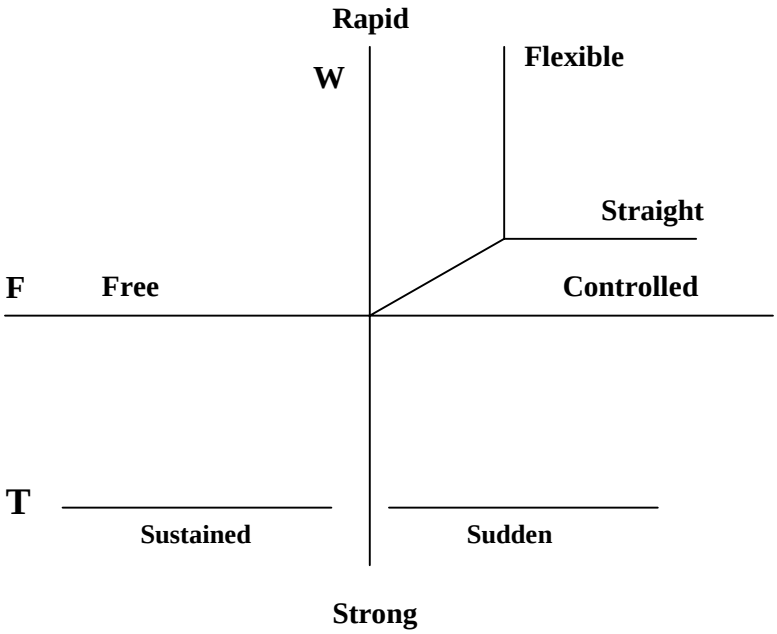

Figure 1. Laban's Table of Efforts where **W** means weight, **T** time, **S** space and **F** flux**.**

Besides the scientific point of view on the concept of motion we have in this interdisciplinary piece an artistic dimension when a human body creates transient images with strong symbolic interpretation.

Our method has been basically observation of a multitude of motions and a subsequent analysis of this set of motions and to extract from it those ones, which seems more interesting for our purposes. Another interesting aspect of ELEMENTARIDADES is that dancers dialogue with sounds, so they do not relate motion to music following the tape timeframes, but music and motion are complementary when the piece is performed

3. THE SOUND ENVIRONMENT

The music of ELEMENTARIDADES embodies, in its conception, reducionist aspects, not in *stricto sensu* as minimalist music, but as sound representation. In its gross structure it is kind of a programmatic music since it contains musical gestures derived from the Standard Model of particles as well from the Labanian decomposition of complex motions. In order to compose the music, we have made use of some computer music software developed at Interdisciplinary Nucleus for Sound Studies (NICS- UNICAMP) such as KIKLOS, Vox Populis, Curvasom (Maia et all, 1999; Manzolli et all, 1999).

The main idea here is to assign (and this is an arbitrary act of the composer) some sounds to each particle we are considering as well a sound representation of its properties, such as light, heavy, strongly or weakly interacting with other particles, etc. These are fundamental blocks to construct the sound environment. Most part of them was generated by software developed at NICS as mentioned above. So we have sounds representing electrons, quarks, muons, etc. This material is then worked out in

a “polyphonic” way resulting in a dynamical and complex sound mass evolving in time.
Here we had in mind an application of the concept of “transference of structures” from physics and the art of motion to domain of sound. In a recent work, (Manzolli & Maia, 1998) we presented the notion of “sound functor” which has just this property of transfer structures from a category of objects to another one, preserving relations and operations between objects in both categories. Below we show two diagrams of processes used in the composition of sections Baryons and Chaos.

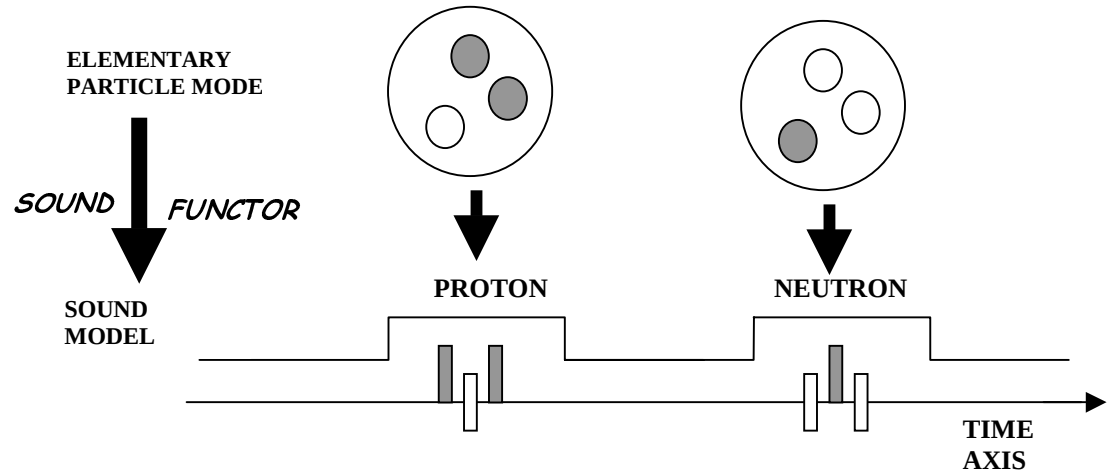

Figure 2. Proton and Neutron quark structures and their correspondent sound blocks used to compose the section **Baryons**. Observe the symmetry between these two structures based on the inversion of the sound blocks inside the baryon sound environment.

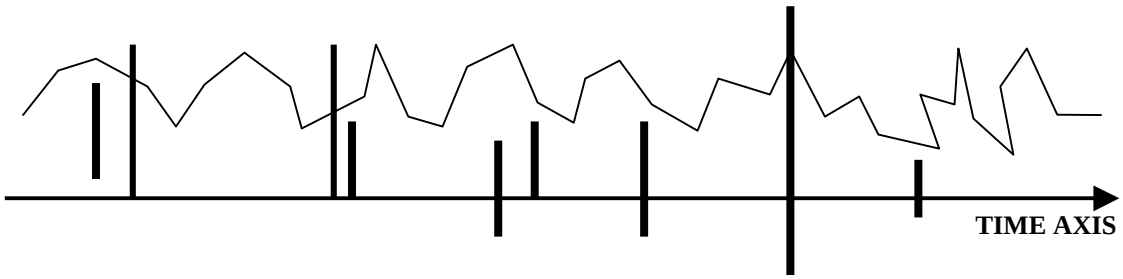

Figure 3. Chaos Section’s Diagram showing very short percussive sounds generated by the interactive composition system Vox Populi is overplaced on a continuous sound background.

4. CONCLUSION

In this paper we described the construction process of the piece ELEMENTARIDADES. As stressed above, ELEMENTARIDADES is an interdisciplinary piece in its essence. In addition it could be used for educational purposes in choreography. So it is suitable to be performed as case study, mainly for Labanian notation approach to the study of motion.

From the point of view of computer music composition it has a reducionist structure, since its composition was suggested by an analogy to the Particle Physics Model. In this way fundamental sound blocks are introduced and worked along the

piece using the concept of Sound Functor (Manzolli, J & Maia, A. (1998)). This is an application that transfers structures and operations from a category of objets to another one, which in our case is a set of synthesised sounds.

ACKNOWLEDGEMENTS

Part of this project is possible through the support of FAPESP to the Gesture Interface Laboratory in which Vox Populi was developed.

REFERENCES

Laban, R. (1999) L'arte del movimento. Ephemeria Editrice, Bolonha, ISBN 88-87952-00-6.

Maia, A, R. Valle, J. Manzolli & L. N. S. Pereira (1999). A computer environment for Polymodal Music, Proceedings of VI Brazilian Symposium on Computer Music, Rio de Janeiro, pg. 87-94.

Manzolli, J., A Moroni, F. von Zuben & R. Gudwin (1999). An Evolutionary Approach Applied to Algorithmic Composition. Proceedings of VI Brazilian Symposium on Computer Music, XVI I Congress National of the Brazilian Computer Science Society, Rio de Janeiro, pg. 201-210.

Manzolli, J. & A. Maia Jr. (1998). "*Sound Functors Applications*". Proceedings of the V Brazilian Symposium on Computer Music, XVI Congress National of the Brazilian Computer Science Society, Belo Horizonte.