MARCO STROPPA'S COMPOSITIONAL PROCESS AND SCIENTIFIC KNOWLEDGE BETWEEN 1980-1991

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ABSTRACT

The purpose of this paper is to show the creative relationship that can be established between scientific knowledge and musical innovation, through the example of Marco Stroppa's work performed between 1980 and 1991 in three specific places: Padova CSC (and the Conservatory of Venice), Ircam (Paris) and MIT (USA).

The following methodological tools allow to understand the links between Stroppa's technico-scientific innovation, and musical invention: an analysis of his training years from 1980 to 1983 and of the main sources of cognitive models; a genetic study of the work *Traiettoria* (1982-1988), that is, the systematic study of traces, sketches, drafts, *computer jotters* and other genetic documents; written work published by Stroppa between 1983 and 1991; multiple interviews with the composer and witnesses of the period; a partial reconstitution under *OpenMusic* (*OMChroma workspace*) of the electronic part initially performed under *Music V*.

In fact, *Traiettoria* constitutes what can be labelled a laboratory of Marco Stroppa's "workshop of composition".

1. INTRODUCTION

Marco Stroppa's musical composition process can be traced by means of a genetic-type inquiry relative to the sketches and other initial documents of the work *Traiettoria* (1982-1988), a piece for piano and computer generated sounds, which is the essential moment of this art-and-science articulation. The eighties were the time when this dual formation crystallized into a spirit of invention framed by the dual reference to scientific and musical worlds.

After highlighting the advantages and drawbacks of the bivalence of Marco Stroppa's competence, this discussion will describe how suitable were the conditions for him to assimilate scientific knowledge at Padova CSC (Italy), Ircam (France) and MIT (USA). These conditions led Stroppa to define a "workshop of composition" comprising, first the physical location of his work, second, the technological tools, and third, the experimental methods and intellectual scientific surroundings. For each of these parts of his workshop, it is worth describing how the worlds of scientific research and musical invention can enrich each other.

2. STROPPA, BOTH COMPOSER AND SCIENTIST

Marco Stroppa's personality provides a perfect basis for the study of the interactive relationship between scientific and art research. This interaction stands out in Stroppa's work, in particular in *Traiettoria* (1982-1988)[1], a work written for piano and computer generated sounds. As regards the man himself, beyond his work, and following the example of some famous predecessors such as John Chowning or Jean-Claude Risset, Stroppa is often considered as a scientist by the artistic community, such his competence has been proven in the field. This artistic researcher is thus equally a skilled science and technology researcher.

Before approaching the genealogy of this dual competence, it is worth pointing out the remarkable advantage brought by this bivalence for a creator. The conclusion fed back from composition-related problems and solutions afforded by scientific and technical means led young Stroppa to develop his very affirmative and powerful creativeness. Although *Traiettoria* is only his second piece of work, it is already classed as a major work of the mixed repertoire. On the other hand, bivalence may have some drawbacks. The relations nurtured by artists and scientists may produce profitable accidents which cannot happen if the two types of competences are possessed by the same person. The discussions and requests of musical assistants or producers of computer-generated music and other scientific researchers may produce new ideas likely to generate compositional innovations. Unlike Stroppa's predecessors Risset and Chowning who made a dual career, Marco Stroppa finally chose to take the privileged road of composition, without however leaving aside scientific aspects (through reading and daily contacts with engineers, computer staff and researchers).

[1] Scores published by Ricordi [1] and recording published by Wergo and Stradivarius [2].

3. IDEAL TRAINING CONDITIONS

3.1. Training sites: CSC and Conservatories (Italy)

The dual competence of Marco Stroppa is primarily linked to the institutional context of the articulation between the Conservatory of Venice and the University of Padova CSC. Toward the final years of his training as a highly confirmed pianist and composer at the conservatories of Milan and Verona, Stroppa simultaneously followed musical training at the conservatory of Venice and at Padova CSC (1980-1983), where Alvise Vidolin helped him acquire scientific knowledge related to the domain of sounds: signal processing, acoustics, psychoacoustics, sound synthesis, fundamental computer science, etc. On the occasion of interviews made with Stroppa, he declared that this simultaneous training led him to build a composition method which does not differentiate work on notes and work on sounds.

When his training was partially completed, Marco Stroppa embarked on a project with the aim of entering a music commission of the RAI. However, since he was under no obligation to enter the examination, the project was in fact stemming from his personal determination rather than being a mere answer to a proposal. This was indeed the first of Stroppa's personal projects, since *Metabolaï,* composed in 1982 and the first of his works to be classified, was actually written to validate his composition studies. Thus, this scientific/technical and musical dual training led the way to the birth of the idea contained in the *Tre Studi per un progetto* which eventually became known as the three movements of the work named *Traiettoria*. Stroppa's initial intention was to work on the microscopic size of the sounds, as a follow-up to the scientific approach of his studies at the CSC. Stroppa's reflection focused first on a work for *pianoforte* only, and on the resonance capability of the natural acoustic characteristics of the instrument. He soon began to fully use his dual competence by writing a "synthetic orchestra" ("orchestre synthétique"), an expression by which he defined piano accompaniment by computer-generated synthetic sounds [3].

3.2 Laboratories and institutes: Ircam (Paris, France) and MIT (Cambridge, Mass., USA)

Pierre Boulez invited Stroppa to enter Ircam at the beginning of 1983 where his first intuition was soon confirmed. He remained until the end of 1984, further enhancing his relationship with the scientists. At Ircam, institute whose activity is precisely centered on the articulation between art (music) and science (acoustics), Stroppa could fully validate his first attempts at writing the first two movements of his project. He could thus refine his reflection, in particular through the decisive discovery of McAdams work [4, 5]. In addition to the fusion/separation of the aural stream[2], today, *a posteriori*, whenever Stroppa mentions those notions which were noteworthy to him, he also cites for example the "timbral space" [6]. These notions were under study at the time and they were transmitted by means of a high number of characteristic sound samples which are unforgettable for Stroppa.

During his presence at MIT (Cambridge, Mass., USA) between 1984 and 1986, Stroppa followed high-level courses in domains rather far removed from the music field, but which were to boost his fertile imagination: computer music and cognitive psychology, and also artificial intelligence, structured programming, expert systems, etc. He was inspired with musically oriented reflections stemming from his knowledge of professorial work such as *Cognition and categorization* [7] which induced him to imagine his Musical Information Organisms [8].

These various places, where it was easier to meet scientists and to work on machines, constituted a part of the "workshop of composition" in gestation at the very beginning of Marco Stroppa's composer career.

4. *TRAIETTORIA* COMPOSITION WORKSHOP

In order to explain how the scientific knowledge and the musical creation are articulated, it is necessary to minutely describe the composer's workshop. This word "workshop" must be understood as the work environment in a wider sense than is the case for artistic crafts or painters' studios. For clarity's sake, the following brief typology describes in three points the composer's workshop as designed by Marco Stroppa for *Traiettoria*.

4.1 Physical location

As mentioned above, Stroppa designed his work both theoretically and practically in three different places: at Padova CSC for the premises, and also for the generation of the synthetic sounds (*Music V*[3] and *ICMS*[4]) of the different movements; at Paris Ircam for the composition of the first two movements, *Deviata and Dialoghi* (creating score for piano, and *computer jotters*); and finally at Cambridge (Mass.) MIT for the continuation of the project with *Constrasti* (again creating a score for piano, and *computer jotters*). Cross-checking his notebooks and sketches with the archives of the different research centers allow to trace his itinerary.

At that time, composers led a nomadic existence to find research centers which were the only places where high-performance computers could be found. This also provided composers an opportunity to meet researchers in particular at the CSC and the LIMB [9]. Stroppa always generated his synthetic sounds at the CSC. Therefore, Stroppa did not go to Ircam or MIT to use computers but indeed to look for places at the heart of research combining music and science. These encounters with the researchers and their intellectual surroundings constitute a third aspect of the workshop (ref. part 4.3). His first tests on the natural resonance of the piano were performed at his place of residence for *Deviata*, then at Ircam for *Dialoghi*, but the latter part of the writing work (the piano

[2] Subject studied in part 4.3.3.

[3] Ref. part 4.2.1.

[4] *Interactive Computer Music System* is a construction and mixing program written by Graziano Tisato (CSC).

part as well as the synthetic sounds) is achieved whenever possible depending on his successive trips and places of residence.

4.2 Technological tools

The expression « Technological tools » covers, in addition to the computers and software programs, all the technical prostheses at the disposal of the composer. Part 4.3.1 expounds the tests performed on instrumental writing. As for sound synthesis composition, this incited Stroppa to opt for an original computerized environment dedicated to composition – or better said, to his own composition method. Hence, sound synthesis used Fortran supported routines under *MusicV* in the eighties, *Carla* at the end of the eighties and beginning of the nineties for Computer Assisted Composition (CAC), then a *Chroma* library under *OpenMusic* (in control of *CSound*) in the nineties and the next decade, and *Antescofo* from 2007 on for real-time electronics.

4.2.1 Music V

To further explore the above-mentioned resonance logics, Stroppa felt the need to prolong the natural resonance of the piano with computer generated sounds, not only to cover the acoustic sound with an electronic veneer, but also to provide the piano with a wider range of resonance. As for the selection of *Music V* versus real time (with the 4i entrusted by Di Giugno to the CSC in 1982 – shortly after the project began), it would not be surprising if this were directly due to the rigorous training he received from his teacher Alvise Vidolin. The texts written during the genesis show that Stroppa had highly precise ideas about the types of artificial sounds and resonance he wished to add to the piano sound. It was because Stroppa mastered *MusicV* in the same manner as a composer would for orchestration that he could compose computer generated sounds in a "synthetic orchestra" [3] which was capable of accompanying the piano much more efficiently in terms of perception than real-time computer-generated sounds. Moreover, *MusicV* is capable of efficiently rendering the most intimate and microscopic sound components. These ideas were directly derived from his training in acoustics and psychoacoustics and also from his earlier work on the piano, in particular the pianistic touch which enables musicians to enter the microscopic properties of sound. Jean-Claude Risset, another qualified pianist, was to live the same experience. This is why Stroppa actually "composed the sound itself " [10], within this new paradigm created almost two decades before.

It must also be noted that *Music V* offers a software architecture designed for and according to the wishes of the composers [11, 12], in the sense that the *score* and *orchestra* ergonomic functions are designed to offer musicians a direct link between acoustics and music. This results from pooling scientific thought and musical requirements at the *Bell Labs* under the sponsorship of Mathews and Risset. It is worth noting that in this case, tools were common both to scientists and composers. The aim was to both acquire new scientific knowledge (*Bell Labs*) and generate musical inventions (Risset, Stroppa, Harvey, etc.).

4.2.2 Carla

Another software, *Carla*, was designed following Stroppa's work on *Traiettoria*. Stroppa settled on two types of matrix-based chords in *Traiettoria*: one was more specifically used in *Deviata* and the other in *Dialoghi*, and both were used jointly in *Contrasti*. In addition, he frequently had to manually perform simple operations on these chords such as inversions and complements, so as to dispose of a range of different chords connected by common notes or intervals. After *Traiettoria*, according to pre-defined requirements, Stroppa continued to compose "by hand" this type of harmonic aggregate he named "Vertical Pitch Structure" (VPS) [13], for example for his piece of work *Spirali* (1989). Toward 1988, he entered Ircam with Francis Courtot [14] for the development of a Prolog 2-written CAC tool called *Carla*, which enabled the production of harmonic material under requirements to be specified. This requirement-ruled programming tool was used for *Elet… Fogytiglan* (1989, 1997, -) and for *Miniature Estrose* (1992, 1995, 2000, -), then it was re-written in LISP.

4.2.3 OMChroma

Upon the creation of *Traiettoria,* Stroppa's "software workshop" was closely dependent on the requirements of the studios, in terms of utilization of the machine time-shared by the composers and the computer and/or science researchers, the extremely long computation time, and the unadaptable configuration of the software programs. *OpenMusic* is a CAC software which enables Stroppa to implement synthesis control patches. The synthesis control support to be loaded in *OpenMusic* (1999-2000) was rewritten by Stroppa on his own, then with the help of Carlos Agon *et al.* [15, 16, 17, 18], Serge Lemouton for the *OMChroma* library and more recently Jean Bresson for the latest *OMChroma* spinoffs [19][5]. Incidentally, *OMChroma* library was widely shared by the community of composers, notwithstanding Stroppa's composing practices. On this support, Stroppa wrote a Workspace entitled *Traiettoria* (2002) more pliable as a graphic interface which enabled him to re-create identical original sounds. The way this synthesis was made in delayed time was reproduced, in particular thanks to the proposed choice between 1/ entering data in Lisp language or 2/ specifying these data directly in the graphic interface. Hence, the procedures used in *Music V* and inscribed in Stroppa's *computer jotters* upon composition could be thoroughly reproduced (and partially reproduced by Stroppa himself with his Workspace) in *OMChroma*.

[5] Notwithstanding the reference [19], the most recent developments are published in C. Agon, J. Bresson and M. Stroppa, OMChroma: Compositional Control of Sound Synthesis, *Computer Music Journal*, Summer 2011, Vol. 35, No. 2, pp. 67-83.

4.2.4 Antescofo

Antescofo is an example of software created to fulfill the wishes of a composer. Two decades before, Philippe Manoury and Miller Puckette had innovated in the instrument/electronics interaction with the score follower concept under *Max/MSP*. Nevertheless, the relationship between the musician and the electronics was still somewhat unbalanced. Stroppa had always shown some hostility to real time [20] because this can sometimes produce anti-musical conditions, or more precisely a technological rather than musical relationship. This time, Stroppa decided to follow this path in 2007 in collaboration with Arshia Cont by envisaging a man/machine predictive device, which would be more in phase with the cognitive reality of the time synchronization between two performing musicians in chamber music conditions. Stroppa then fitted in the continuity of several pieces of work "for chamber electronics", i.e., an autonomous electronic portion with artificially intelligent reactions. Crossing Marco Stroppa's and Arshia Cont's[6] testimonies confirms the existence of "mutual inspiration" between the two protagonists, thus resulting in a software program at the meeting point of scientific and musical researches.

4.3 Experimental practice and intellectual scientific surroundings

4.3.1 From the tests on piano resonance to the "Treaty of resonance"

The *Traiettoria* notebooks show that he performed numerous tests on piano resonance. Direct work on piano was inspired to him by the acoustic phenomenon approach of sound he acquired while training at the CSC. Indeed, his aim was not to test harmonic sequences or chords (even when the work was based on two "manually" produced chords). He did not attempt to reproduce a piano spectrum by notes as would a spectral musician, but rather, using only the natural resources of the piano (the three pedals, the keyboard touch), to generate incredible resonances generally outside the range of standard piano writing. In view of the extreme difficulty in fully concretizing his musician wishes, Stroppa used electronic writing to create resonances. There again, direct practice on the piano without the aid of computers seems widely nurtured by his very extensive knowledge of the physical and psychoacoustic phenomena.

This preliminary work on the piano was then the subject of another piece for piano solo, *Miniature estrose* (1992, 1995, 2000, -). It can be noted that the piece brings the final touches to the initial project of *Traiettoria* which was meant to be written for a piano solo. Less than a quarter of a century later, Stroppa had Ricordi [22] republish the scores, to which he added the "treaty on resonance", the end result of his above-mentioned former experiences.

4.3.2 Sub-routines (PLF)

In the pre-compositional phase, Stroppa wrote PLF sub-routines. To illustrate the correspondence between the types of syntheses and the families of sounds at the beginning of the compositional process, here are three examples drawn from *Deviata* :

- PLF 10 produces additive synthesis to generate cluster type sounds (family C, see Figure 1)

- PLF 20/21 produces what is called granular synthesis nowadays, to generate glissandi in particular (family A)

- PLF 33 produces FM synthesis to generate attack/resonance type sounds, or more globally the sustain of complex sounds (family B)

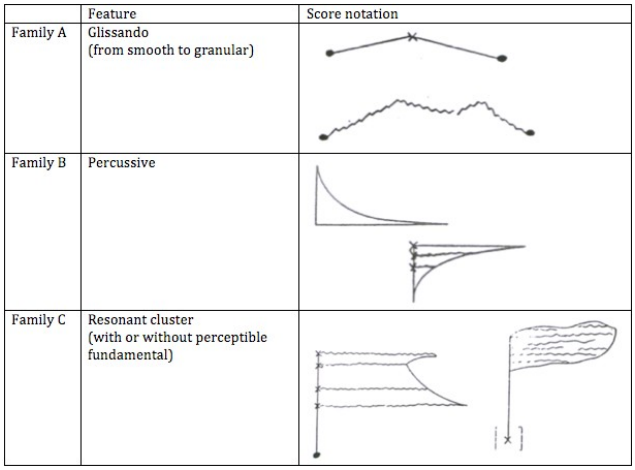

Figure 1. The 3 sound families in *Deviata*[7]

4.3.3 Tversky's contrast model, McAdams' aural stream fusion/separation

As regards Marco Stroppa's intellectual and scientific surroundings, it is worth mentioning the "mandatory readings" of his recent training at the CSC, in particular the work of Roederer [23]. In this context, *Cognition and Categorization* by Rosch and Lloyd [7] is a bedside book for Stroppa. In 1982, basic but nonetheless essential psychoacoustics principles were also laid out in his CSC courses of that time. For Stroppa, psychoacoustics for sounds synthesis was tantamount to what the orchestration treaty is for orchestral writing. The knowledge of Roederer's [23], McAdams' [4, 5] or Wessel's [6] work scientifically validated his initial intuition and at the same time helped him to systemize his musical thoughts.

Based on this knowledge of the cognitive and psychoacoustic science, Stroppa built up the concept of Musical Information Organisms (MIO), in the midst of the constructions of sound families (ref. next paragraph). What mattered for Stroppa was the perceived result, taking a precise account of observations drawn from cognitive and psychoacoustic sciences. It is clear that numerous techniques for local or global writing [8] are more or less direct transpositions of these psychoacoustic "rules". But

[6] See [21], at 4'.

[7] Transcription of the sounds families, from [3]

there again, the knowledge of these concepts was contemporary with his writings, often providing a confirmation of his first musical pages as in the first two movements *Deviata* and *Dialoghi*, and sometimes in anticipation as in the third movement *Contrasti*. In the latter case, deeper knowledge of the latest discoveries in cognitive and psychoacoustic sciences enabled Stroppa to make the most of the dual concept of similarity/contrast model [24, 25] and fusion/separation.

The "Contrast model" was taken up by Stroppa in an example which he used as a support for composition courses dealing with *Traiettoria* (see Figure 2).

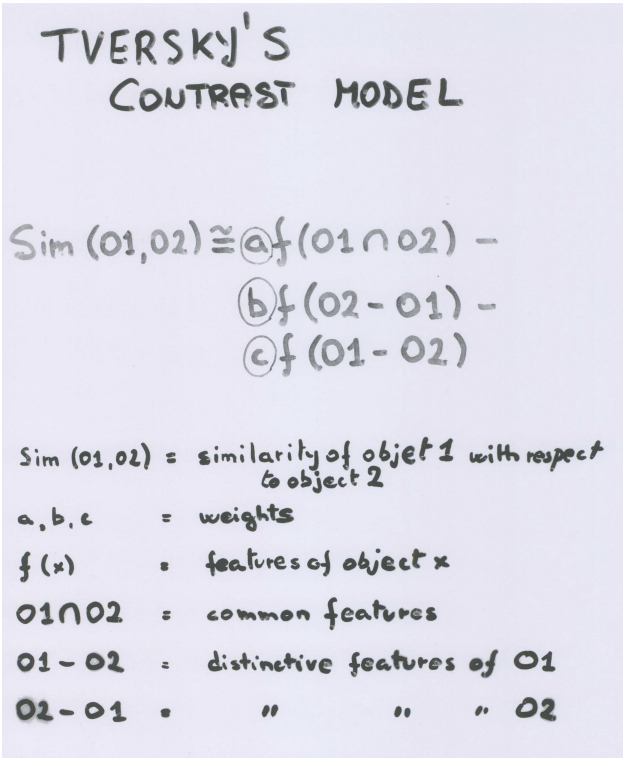

Figure 2. Tversky's contrast model reproduced by Stroppa

To explain the link existing between these different scientific concepts and Stroppa's composition processes, it is necessary to detail how he designed the MIO. Each of these consists of several sound objects, in turn containing more basic musical characteristics. Stroppa's compositional process classified these sound objects according to Tversky's model similarity index. Then he could identify organisms formed by the association of these objects: the MIO, which have a strong identity recognizable on perception.

Upon assessment of the similarity index between two sound objects, the contrast model combines three terms provided with weighting coefficients linked to the auditory judgment and closely associated to Stroppa's decision : 1) characteristics common to both objects, 2) characteristics specific to the first object, 3) characteristics specific to the second object. Thus for an MIO consisting of two superimposed sounds, either of the following cases may occur :

1) the two sounds are discriminated when the similarity index is low. This separation phenomenon is frequent in *Deviata* with its highly characteristic synthetic sounds as indicated in fig. 1.

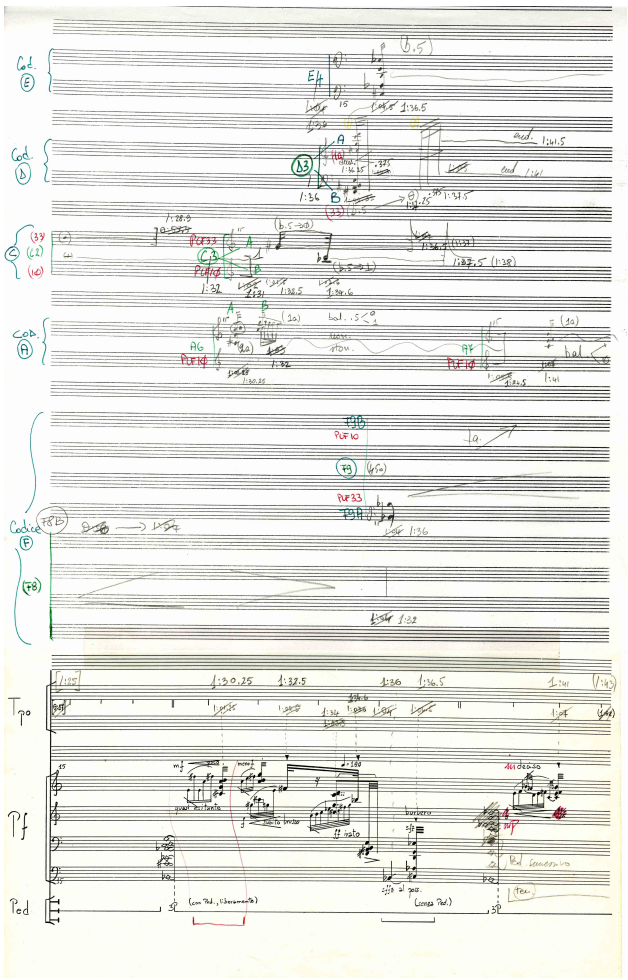

Figure 3. Page 4 of *Contrasti* original working scores, size between A3 and A2.

2) the two sounds cannot be discriminated when the similarity index is high. This fusion phenomenon is frequent in some *Contrasti* MIO perceived as single although they are made of two superimposed sounds. As revealed by the *computer jotters*, the most frequent case consists of a high-pitch part generated by additive synthesis, and a low-pitch part generated by formant FM synthesis (see Figure 3: D3A et D3B). In this large format, mixed scores used by Stroppa as a working document to compose the mixed passages of *Contrasti*, the content of the synthesis part can be reviewed finely. Each sound family (itemized with a letter) appears as an instance (numbered in increments) which can often be divided into two parts (A et B, as mentioned above) generated by PLF 10 and by PLF 33 (in this case, sounds C3, D3, F9). This writing technique per MIO implemented for the electronic part also operates as an extension of the piano part. Indeed, the harmonic content of aggregate D3A (synthetic sound at 1'36"25) is played on the piano at 1'34" and, in the same way, the harmonic content of agregate D3B is played on the piano at little before

1'36"25 (see Figure 3). Thus in this passage, the recurrent doubling of the piano by the electronic sound (synchronous or offset) infers that an outstanding musical passage (chords, stressed notes, etc.) is most often perceived globally as an organism (whether it is instrumental or electronic).

4.3.4 Structured programming

Between September 1984 and September 1986, Stroppa completed his training at the MIT. He then devoted himself to fundamental computer science, making attempts at structured programming (basically Fortran language used by *Music V*). Readings such as *Structure and Interpretation of Computer Programs* [26], relative to these domains obviously little connected to composition, provided a rational explanation of how to perform compositional practice. The main idea is the decomposition of a problem in primitives. Stroppa declared in an interview: "From a compositional point of view, what is my primitive ? Where am I to start the definition of a material from the viewpoint of a composer (material that may be complex but that I use as a unit)? Is it a chord, a note, a note spectrum, a rhythm, a 3-minute long process ? "[8].

In addition, he suggested that, for the compositional work, he preferred using a Top-down concept (man language to machine language): "Because at the top is the problem as I understand it and not as it is presented by the machine. And this way of working, very well explained by Sussman, is imperative epistemology. It is a study of the knowledge structures, although not a declarative one (not defining what it is), but giving a clue as to how the problem can be solved. This imperative epistemology scope – actually, I found this later -, is exactly the type of problem we composers are confronted with"[9]. He finished by saying that: "I have discovered that writing a program was like writing a fugue"[10]. For a composer, decomposing problems into primitives (Top-down) is a permanent act. Then, the creation process is completed by combining several primitives (Bottom-up) in sequences of primitives[11]. For example, to create an MIO *via* sound synthesis, Stroppa had to decompose abstractly the MIO into primitives, that is, in different sound objects. After making a step-by-step synthesis of each of these sound objects, he must recombine them to make up the MIO. He repeated the process for other MIO until a trajectory (*Traiettoria*) was gradually traced by these MIO.

4.4 Personal background of the composer

Without intending to be exhaustive about this final aspect of the composer's workshop, it can be noted that Stroppa's thoughts were experimental. Music composition is equivalent to musical research. In other words, Stroppa's works were never finished. He liked to keep the work as a sketch which could be updated and improved later, and above all used as a matrix or support for novel ideas for the next work. For example the compositional process by organisms (MIO) and the attempts at piano resonance were repeated in *Miniature Estrose* (1991). Stroppa followed a thought process akin to scientific experimental reasoning.

5. CONCLUSION

Structured programming, cognitive sciences, acoustics and psychoacoustics boosted the thought process of Marco Stroppa relative to his language, his tools, in short his "workshop of composition" in the eighties. By reading scientific texts and acquiring scientific knowledge, Stroppa found confirmation of a number of musical practices. Simultaneously, this scientific knowledge contributed to the delineation of an autonomous mind, free from the restrictions imposed by esthetic trends. Finally, Stroppa's dual scientific and musical competence, and his closeness to researchers have also contributed to developing his knowledge and to the designing of software programs dedicated to musical research.

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Reproduction of genetic documents kindly authorized by Marco Stroppa.

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[9] 08/01/2010, interview of Marco Stroppa by Noémie Sprenger-Ohana and Vincent Tiffon at Ircam (Paris).

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