Meta-Instrument 3: a look over 17 years of practice

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ABSTRACT
The Meta-Instrument (M-I) is a new instrument for computer music. Since 1989, three backward compatible prototypes were designed involving custom developments in electronics, mechanics, computer science and music. This paper presents the third generation of M-I, and a few ideas that emerged from the past 17 years of playing it.

Keywords
Audio-graphic portable instrument, WiFi, Ethernet, Répertoire

1. GENESIS OF THE PROJECT
From 1983 to 1988, we worked at the Puce Muse studios , on the simulation of sound movement in a 3 dimensional space. This research led to the conception of the Octophonic Spatial Processor. This machine compute the sound level distribution over 8 or 16 loud-speakers, from cartesian or polar sound coordinates.

The loud speaker positionning can fit into various geometries: line, cube, circle...etc.

After several experiences, we use essentially, since 1988, a configuration with the loudspeakers placed at the corners of a cube. This cube fits into a space matching either the stage or the whole theater.

The various musical pieces composed with the system quickly highlit the link between the movement of sound in space, and its spectral movement. The nature of this « intern » Vs. « architectural » movement relation is a complex topic, since it covers several fields of knowledge: acoustics, music, and cognitive sciences.

Nevertheless, the musical fields opened by this -very stimulating- research faced a real problem, when adressing the conduction of sound. Indeed, if space is omnipresent metaphorically in music, musical instruments are not meant to move sounds in space. The question is thus to imagine a system able to simultaneously displace sounds in space while making their spectrum evolve.

The 2nd goal of the Meta-Instrument was to be able to play the « musique concrète » invented by Pierre Schaeffer[1], not for recording's sake, but to play it live in a concert. To link the revolution in electroacoustic techniques, that allow the musician to work with all recordable sounds, not to create musical pieces that remain fixed on sound-tapes, but find the ephemeral dimension of playing live music again.

2. HOW THE META-INSTRUMENT WORKS
These two questions led to the conception of a general system, made of three parts: gesture sensing, gesture transformation, and perception.

The Meta-Instrument main function is to catch the gesture. It is thus a transductor meant to measure precisely and digitalize the musician gesture. A first version was built in 1989 and still works today. A second generation, compatible with the first one, exists since october 1995. A third version, compatible as well with the previous ones, is operational since december 2004.

The Meta-Instrument is connected to an ethernet analogic interface. The 54 sensors data are sampled at 500Hz, with 16bits resolution.

This interface is then linked to a computer, where the gestural data are analysed and processed by programs developed with Max (© Cycling74/IRCAM) [2]. Today, there are more than 150 « software instruments » developed for various compositions. Each « software instruments » runs within a standard architecture called « bank », allowing switching and mixing management between the various « software instruments », driving sound, graphic or lighting systems.

3. THE SURPRISES OF PRACTICE
3.1 The pulp or finger intelligence
Essentially, the Meta-Instrument is a measuring system, with its tolerances and measurement errors. Three generations of them were needed to reach the gestural finesse of the fingers pulp. Indeed, each finger act simultaneously upon 4 keys, stimulated by longitudinal and lateral movements of the finger's pulp.

The minimal pressure measure is of 10 milligrams, and sampled every 2 milliseconds. This precision allows now to compute speed and acceleration accurately enough to link sound energy to gesture energy. This quality of measure gives the sensation of « seeing » the finger movements on the screen. As a comparison, the first Meta-Instrument measured only 10g or so every 20ms, with only one key per finger! Moreover the rigidity of the key used to give tenditinis.

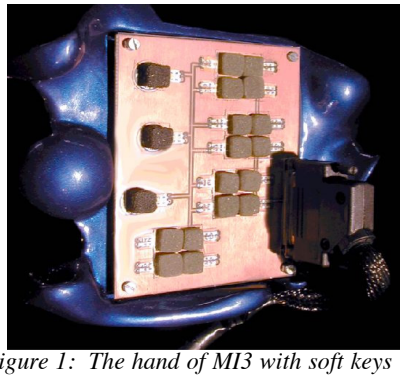

Figure 1: The hand of MI3 with soft keys

3.2 A wide range of possibilities

The number of possibilities given by the 2nd generation of Meta-instrument at every time sample is up to 2^{7x32}, or 2^{224}, which is about a billion times more than the number of atoms in the universe! This vertigo can be sensed when changing « software instrument ».

It happened at the beginning to the meta-instrumentist not to know anymore « where he/she is », and which musical space, which algorithm runs under the tip of the fingers. This kind of « blackout » disappear with the gesture memory linked to musical memory. Moving while hearing inwardly the musical software wakes up the gestural knowledge of the algorithm.

3.3 More conductor than instrumentist

In this temptation to play the orchestra-man, an attractive instrument is one producing broad and generous sound phenomenons, which surpasses power and tessitura's limits of traditional acoustic instrument. An instrument generating much more with less, as does the conductor baton with the orchestra.

Most of the software-instruments are closer to the conductor logic, than the instrumentist's. The relation with sound is often macroscopic, driving fluxes, speeds, orientations, probabilities... It is also in this direction that the possibilities are the newest, allowing interaction of sonic structures through phrasing and precision that have never been heard.

In this case, the gesture is not necessarily linked to the creation of acoustic energy, nor is it to the systematic choice of notes. For each musical idea, we have to decide on the gesture/sound mapping.

3.4 Position and variation gestures

Several software-instruments work with a double pinciple:

- Position gestures, which determines a more or less stable and quick selection in the algorithm.
- Variation gestures which , allowing for variations around the selected stable state, or “grosse note” as called by Pierre Schaeffer. [3]

In this duality between continuous and discrete behaviours, it seems that the Meta-Instrument fits the continous control better, allowing for arabesques, and roundness. The first corresponding more to keyboard instruments, the other to instruments like violin or voice.

3.5 Fast fingers, stable and precise arm

A software instrument can be controlled through many different ways. The same gesture can be mapped to any parameter. Although, in this seemingly endless space of mapping, there are some rules quite commonly followed. Fingers are mostly used for their quickness, they can run through the 64,000 values in about 10ms! The fore arm is much slower, but also more stable and precise.

3.6 The eye can amplify the hearing

Since 1991, the Meta-Instrument plays the lightings and since 1999, it controls computer graphics. The arrival of visual elements, in a musical context, sometimes encountered hostile reactions: “Music is enough itslef, graphics are here just to hide misery”

And yet, playing a musical instrument is also perceived by the eye. For exemple, the movement of a musican juste before starting, silence at the end before applause, are musical moments despite the absence of sound.

These disappear on audio recordings, when the audience cannot see what happens. Similarly, the score is a visual element which, when followed, greatly modifies the hearing. The experience of listening to a piano play, while watching all the mechanics is another exemple.

The Meta-Instrument always uses symbolic representation, in the software instrument, before producing sound.

It is thus possible to use the same parameters to simultaneously run visual algorithms, and to amplify the hearing, either by extending the notion of score, or by a representation of the algorithms.

Of course, interaction between the eye and the ear is a very complex topic, which goes beyond the scope of this paper. Let's just keep this exciting idea in mind: music is enlighting the shadows' light.

3.7 Silent instrument

The development of this work eventually gave birth to purely graphic software instruments. These instruments are interesting, because they show a very musical feature: the art of temporal variation. The musician then becomes a movement manipulator, “movement” meaning here the temporal evolution of an object, which can produce sound or something else.

These silent instruments also emphasize the closeness to dance, as well as the difference with it. In this case, the movement of the body is discreet, movements of the fingers' tips are only a few millimeters long, and these gestures need amplification to be seen. The instrument can thus be seen as an extension of the body.

3.8 Static and dynamic force feedback

The force feedback was particularly taken care of. Keys are soft, and continuously measuring pressure, from 0 to 200g, on a 3mm depth. The pressure roughly match an exponential perception of the touch. In the middle of each key, a small spot allows to feel where the center of the key is.

Also, all keys are covered by a soft material, so that fingers can move with ease. This refinement made us let the dynamic force feeback aside. Though research works such as ACROE's [4] really show hopefull results in this direction, dynamic feedback on the Meta-Instrument is only visual and acoustic, for the present time.

Figure 2: Static force feedback - springs & adjustable friction

3.9 After 15 years with crutches, the Meta-Instrumentist now walks!

Two previous generations of Meta-Instrument made use of stands. The third generation is mobile, with straps, and even wireless thanks to WiFi protocol.

This choice was made after considering the changing role of the Meta-Instrumentiste, from soloist playing in front of the audience, to the “Opera conductor” standing in withdrawal compared to the scene. The mobility offers the possibility to stand at the right place, which can change during the concert.

The goal is also to improve the contact with the audience: a musician will play differently when sitting or standing.

Figure 3: The MI3 is portable and wireless

4. WHY PLAY?

This question may sound weird, as we are used to think of music being played by musician. However, recording techniques deepely modified musical practice and the number of professional musicians plummeted over the last years. Is it necessary to mention the meaning or the "play" key, on tape and CD players?

As far as the Meta-Instrument is concerned, the question is all the more important that, beyond the instrumentist gesture, it is possible to record the whole score, with all the nuances, sounds and images.

4.1 An immense pleasure

Without any doubt, the first answer is the pleasure of playing a sound circulating faster than sound, along hundred meters. It is about manipulating images sized a few hundred square meters. More than a megalomaniac pleasure, it is about animating metaphors of the Creation.

4.2 Acting at the right moment

Here, the work is open, and allows to modify trajectories, and reshape forms at any time. Playing consists in finding this fragile, ephemeral, unique moment, and standing ready for the time passing, for the concert room, and of course, for the audience.

4.3 Putting the notion of Art work in question

Rather than "why play?", the question could be "what to play?". What is worth being phrased, and what can be automated? What interactions to play? These questions put the notion of art works in question. There underlie a definition of composition which could be "to create a space where to play".

4.4 Playing to explore new musical spaces

The territories that have been opened by this practice are vasts. We are only at the beginning of discoveries. Many directions, like the research on the sound of gesture, or the sound of image, are still quite unexplored. The progress of this huge work will only be possible through the increase of the number of composers, musicians, developers, and teachers interested in this field of research.

5. FURTHER WORKS

At this stage in the evolution of the Meta-Instrument, and in order to spread its practice, several ways are being investigated.

5.1 Toward a plug'n play instrument

Due to the lack of computing ressources, the Meta-Instrument used to need a complex and heavy system, with a MIDI interface, a digital mixing console, samplers, lighting systems, and an octophonic sound system, along with one or more computers to analyse the gesture data and send control informations.

The Meta-Instrument 3 is now directly connected to the computer through Ethernet or WiFi protocol. The digital mixing console, samplers, and lighting/visuals have been integrated in the Max/MSP/Jitter layers of the software-instrument, thanks to the incredible evolution of computational speed.

The next step is to redefine and standardize an interface for the Meta-Instrument, so that using the software part will not require the musician to be a Max developer, and also to make available the pieces of code, which are constantly re-used, and emerged from long-time practice. In this goal, mapping tools such as IRCAM's MnM [5], and Physical Modeling for Pure Data (PMPD) [6] libraries are two noticeable effort which will ease the complex task of mapping.

5.2 Meta-Mallette: a collaborative alternative to the orchestral instrument

The heaviness of the system described above tended to discourage a teaching of the Meta-Instrument, that had been proposed in a few willing conservatories. Also, starting from scratch with the complexity of the Meta-Instrument may puzzle somehow the novice student.

In 2003, PuceMuse launched the development of a collaborative music system using algorithms similar (but simpler) to those used for the MI, played with joysticks – a cheap interface well known to children. Most of them just did not know that their virtuosity at playing videogames could be used for something else than driving race-cars at 1000 Mph or killing ennemies...

The Meta-Mallette (which fits in a wallet), introducing historical and new synthesis algorithms to the players in an entertaining musical activity, encountered a real success, giving a accurate response to a real need in music schools.

Several composers, musicians, and multimedia artists developed collective games meant to 8 to 30 players. Regular workshops have started to work with various social centers, music school and conservatories, and which enventually constitute a first step for the musicians to more evolved interfaces.

5.3 Workshops and growing community

Besides that, a one year long workshop has been launched in 2004 gathering 10 musicians to learn, and practice the Meta-Instrument along with collective consideration on the complex relation between sound, music gesture, image being controled all at the same time in real time.

The result was very fruitful, raising different approaches, ranging from perceptually relevant gesture/sound algorithms, to adaptation of electroacoustic pieces for live playing, and interactive cinema.

This experience led PuceMuse to build a few specimens, as research centers such as LaBRI[1] and LAM[2] ordered Meta-Instruments. It is hoped that the scientific collaboration will be improved by this direct use of the Instrument in the laboratories.

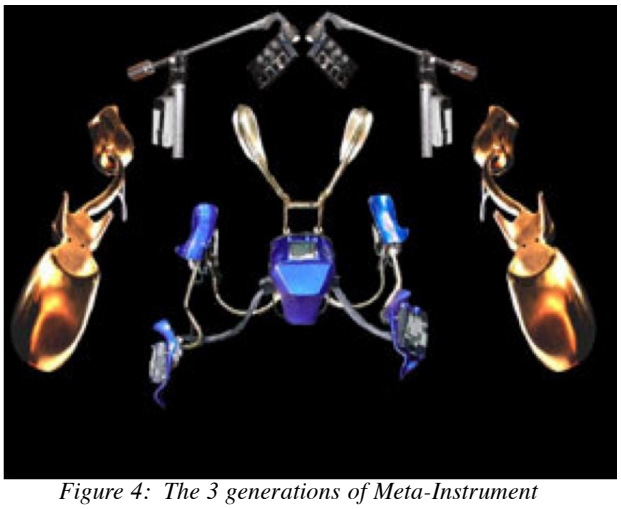

Figure 4: The 3 generations of Meta-Instrument

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