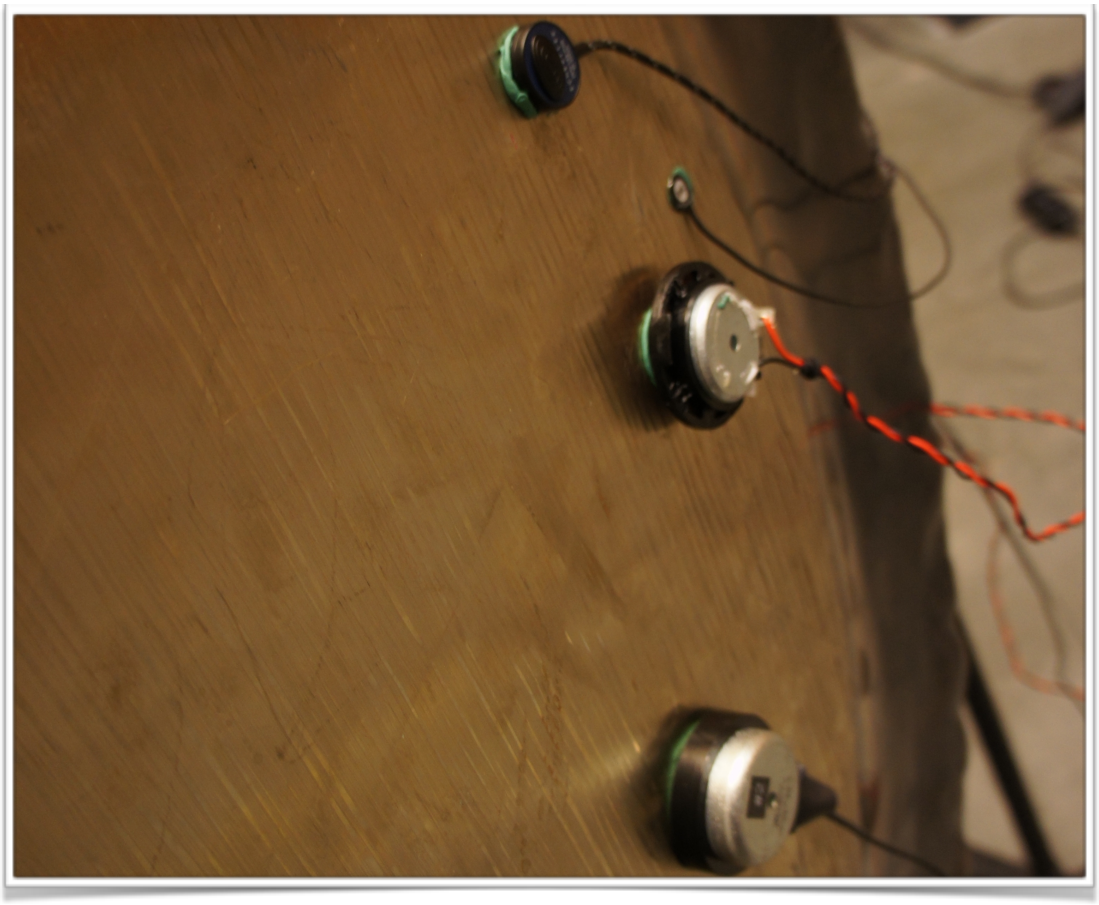
CARMINE-EMANUELE CELLA



Inside-out

Smart instruments for normal people

Innovation and sustainability for music performance and education

March 2019

In partnership with *Ircam* and *Les Percussions de Strasbourg*

ircam Centre Pompidou

PERCUSSIONS DE STRASBOURG

THE PHILOSOPHY

Music listening: global or local experience?

Since many years, electronic music has often been designed using a *global* listening paradigm: it has been diffused using loudspeakers placed around the public, with the performers on the stage. Electronic sounds, then, were perceived as a global acoustic phenomenon clearly detached from local phenomena such as the performers on the stage.

In order to cope with this separation, a common solution has been to cancel local phenomena: for example, the performers have been amplified and diffused in the global space of electronics. In this tradition there are powerful techniques such as ambisonic spaces and wave field synthesis, successfully used for artistic purposes.

Cancelling local phenomena, however, generated in the listeners a sort of *schizophonic* experience in which the sounds had no corresponding source.

A new paradigm for listening, new instruments for people

Is it possible to create a **new paradigm** for listening, in which global immersive properties are respected but at the same time source localisation is preserved? In other words, is it possible to effectively integrate the listening space?

We think that this is possible through the concept of **inside-out instruments**: the electronics is done inside physical instruments (using them as loudspeakers) and the instruments are placed around the public. This is technically possible by using special devices that vibrate on specific frequencies and transmit these vibrations to the resonating parts of the instruments, after processing them with Artificial Intelligence (AI) algorithms.

These devices are also very **cheap** and could indeed open a new phase of musical instrument design that can democratise music performance and education with a major social impact.

THE PROJECT

Inside-out, the piece

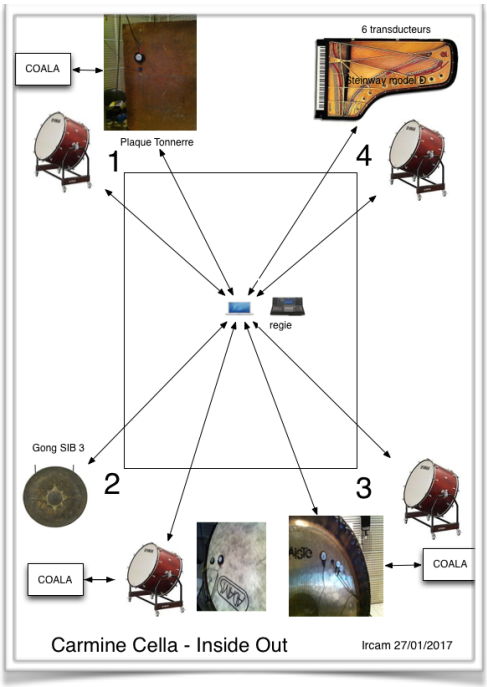
The whole idea begun with a commission by Ircam and Percussions de Strasbourg for a new piece based on smart percussions that we designed during the production (in 2017).

The piece, called **Inside-out**, established several new paradigm changes. With the help of new embedded devices, called **Coalas**, and some cheap sensors/actuators applied on the body of large percussions we managed to create a new *global* musical instrument that is placed around the public and that is played *jointly by all the performers.* This kind of instrument is still in an early stage but showed already great potential for sound design and human-computer interaction.

The following photos show some prototypes developed during the production and the *Coalas*; you can see the small sensors and actuators applied on the body of each instrument.

Xulon: smart instruments for everybody

The central idea of Inside-out was to be able to play a musical instrument **inside another.** We designed specific connection networks by means of *Coalas*, sensors and transducers that made this possible (see picture on the side). *Coalas* have been developed at Ircam in the *S3AM* team. By an intense production period of several months, that involved Ircam and Percussions de Strasbourg, we managed to finalise new prototypes.



After the production of the piece, anyway, we decided to expand our prototypes and these ideas have become the foundation for the design of new *smart devices* that we now call **Xulon.** The main feature of *Xulons* is the possibility to completely change the acoustic nature of the physical instrument on which they are applied and to design new interaction models with the performers. The sound changes depending on the gesture performed and it can vary widely from metal-like to glass-like or wood-like and so on. Several physical instruments can also be connected each other to produce a new *hyper-instrument* that requires multiple performers together and can be placed around the audience.

The photos below show a prototype of this technology, still under development, applied to a tom-toms and bass drums. The work has been done in several residency periods during 2018 in Strasbourg.

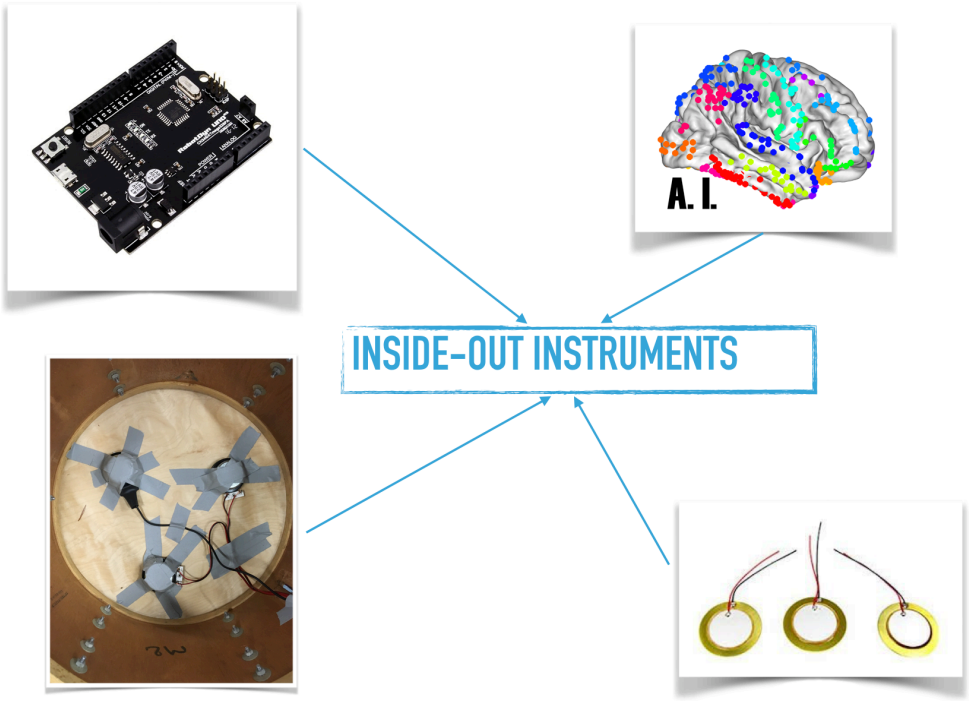
Innovation and sustainability with AI

While *Coalas* are very powerful and capable, they are unfortunately expensive. On the other hand, our new design of inside-out instruments is not only innovative, but it is also very **cheap**! The whole technology needed to build a *Xulon* is made of a sensor (piezo-electric microphone) a transducer and an embedded device developed on Arduino-like platform. The total cost per instrument is **less than 100 dollars.**

Special AI algorithms have been developed for this project in order to create sound processors that can generate quasi-real sounds by copying real physical systems. Specific learning networks have been trained on large amount of input-output couples of real sounds/parameters of a physical modelling system. Finally, the generation part has been ported to the embedded device to be used in realtime. We call this system **physically inspired** sound synthesis.

We believe that this technology can have a huge impact on society: every student in a school could have access to new ways of instrument design, learning about human-computer interaction, sound design and musical performance.

By mixing low-tech components with bleeding edge AI algorithms that run on cheap embedded devices we want to create a new access to music for everybody, with a major impact on musical education.



A connection with Leonardo Da Vinci

The idea of inventing new instruments is not new in history. Italian Renaissance genius Leonardo Da Vinci made some projects about a new hybrid instrument conceived as a mixture between a string and a keyboard called *Viola organista,* depicted in the figures below.

The same idea can be applied to Xulon, where the electronics *augment* the physical nature in order to obtain special characteristics such as pitched tones. Xulon can indeed produce tones and even glissandos. A prototype of Viola organista has been realized by polish pianist Slawomir Zubrzycki as depicted above. We believe that the effort of realizing this prototype is really important; moreover, adding electronics to augment instruments is an important step towards a new kind of lutherie.

References

Webpage: www.carminecella.com/inside-out
Demo of inside-out instruments: https://www.youtube.com/watch?v=R7BnXKTKExI&t=30s
Introduction to the piece (French): https://www.youtube.com/watch?v=qkvJT0sEDs8
Recording: https://www.youtube.com/watch?v=ZUkHMOa1xJA
C. E. Cella, When the light thickens, pour 4 for and live electronics, Ed. Suvini-Zerboni.
C. E. Cella, Inside out, for 4 smart-percussions, Ed. Suvini-Zerboni.

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