

Modularities in interactive music: a case study in the piece *Entre Máscaras* (2023) for cello and live electronics

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SUBÁREA: Composição e Sonologia

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Abstract. This work explores the relationships between modularity, creative practices, analysis, and writing in interactive music, using the piece *Entre Máscaras* (2023) as a case study. The term ‘modularity’, as understood in this work, unfolds in two aspects: (1) the interconnection of interchangeable modules such as code blocks, software, instruments, and controllers that interact with each other by exchanging dynamic information; and (2) the way in which such information modifies signals and data that these modules generate or process (streams of audio, video, control data, etc.). We understand that there is a paradigm in interactive music that involves a modular logic of creative thought. In the first part of this article, we discuss the modular concepts proposed from the perspective of transduction and mediation developed by Simondon. After the initial discussions, we describe the case study’s technical and creative aspects to illustrate the proposed conceptual arguments.

Keywords. Modularities, Interactive music, Simondon, Music composition

Título. *Modularidades na música interativa: um estudo de caso na peça Entre máscaras (2023) para violoncelo e live electronics*

Resumo. Este trabalho explora as relações entre modularidade, práticas criativas, análise e escrita em música interativa, tendo a peça *Entre Máscaras* (2023) como estudo de caso. O termo ‘modularidade’, tal qual entendemos aqui, desdobra-se em dois aspectos: (1) a interconexão de módulos arbitrários como blocos de código, software, instrumentos e controladores, que interagem entre si por meio da troca em tempo real de informações; e (2) a maneira como essas informações modificam os sinais e dados que esses módulos geram ou processam (fluxos de áudio, vídeo, dados de controle, etc.). Entendemos que existe um paradigma na música interativa que envolve uma lógica modular de pensamento criativo. Na primeira parte deste artigo, discutimos os conceitos modulares propostos a partir da perspectiva da transdução e mediação desenvolvida por Simondon. Após as discussões iniciais, descrevemos os aspectos técnicos e criativos do estudo de caso para ilustrar os argumentos conceituais propostos

Palavras-chave. Modularidades, Música interativa, Simondon, Composição musical

Modularities and reflections about technique

In this work, we are interested in the concept of *modularity*. We use this term to refer to creative practices that rely on creating music/sounds through *modular* technical objects and *modulation/intermodulation* processes. These processes originate from the interconnection of physical and algorithmic devices such as electronic musical instruments, acoustic instruments, transducers, controllers, modular synthesizers, and pieces of software. Through these connections, modulated streams of audio, video, and data interact with each other, generating images and sounds.

The emergence of electronics led artists to master new technical devices and weave them into their existing practices, creating a new set of instruments and exploring an aesthetic that breaks with traditional Western musical practices. In the context of interactive systems, the creation procedures reached a unique place for the composer and challenged the traditional logic of conceiving a work in musical composition. The starting point, in these practices, does not rely primarily on conventional music theory anymore. Instead, it embraces a broad and transdisciplinary approach to musical creation, performance, and production.

How do we compose for, and with, instruments and systems that are in constant flux? The traditional composer-role is described above with the idiomatic and supra-instrumental compositional approaches. But perhaps the question itself is flawed, as it is symptomatic of a thinking that defines the composition as a series of linear events in time, symbolically notated in paper format. With digital technologies, the potential is opened up for various new conceptions of the work, such as real-time scoring, interactive pieces, game narratives, and virtual reality worlds (MAGNUSSON, 2019, p. 186).

In this emphasis on process, we can draw a parallel with the theories of the philosopher Gilbert Simondon. Simondon's concept of *transduction* provides a way to understand individuation as a dynamic, open-ended process of structuring and becoming. *Transduction*, as conceptualized by Simondon, is a process of *mediation*, whereby disparate energetic processes are brought together and amplified, eventually forming new structures and individuations. That's why the concept of information, according to the author, should replace the notion of *form*.

Information is something that requires individuation through an allagmatic process of energy exchange, which is transduced from the whole to the part and from the part to the whole. It is not merely a message or data that is sent from one point to another along a transmission line that would be understood

simply as an instrumentalized and indifferent medium. (VELLOSO, 2013, p. 99, translation added).

The sound modulation processes that we are interested in can be related to the transductive chain proposed by Simondon. Interconnections between modules, code blocks, and instruments allow signals to be used to shape and transform other signals (coming from other modules, code blocks, and instruments). Within these systems, signals can both modulate and be modulated, mutually influencing each other and giving rise to new information as they propagate.

Such intermodulation processes, when considered within the framework of Gilbert Simondon's ideas, can be linked to a continuous process of molding. Simondon uses the example of brick manufacturing to illustrate how *hylomorphic* conceptions fail to explain individuation. When conceiving objects as an abstract junction of a formal cause and a material cause, these conceptions do not take into account the real participation of material components of molds used in this process, or all the processes and care necessary to give the clay matter the colloidal properties so that the brick comes to have its final form. In the same way, *hylomorphism* does not adequately address the dynamism of the entire process, which causes the material, when pressed into the mold, to be formed in its final structure.

Based on this example, Simondon addresses the modulation processes of triodes and electronic valves as dynamic molding processes, in which the form/matter dichotomy is insufficient to explain the particularities of the functioning of these technical objects.

In the electronic tube, a low-inertia energy carrier is employed (the cloud of electrons in a field) so that the equilibrium state (corresponding to the distribution and gradient of the electric field) is achieved within an extremely short time compared to the preceding state (a few billionths of a second in a large-sized tube and a few tenths of a billionth of a second in small-sized tubes). Under these conditions, the control grid potential is used as a variable mold; the distribution of the energy carrier according to this mold is so rapid that it occurs without any perceptible delay for most applications. The variable mold serves to change over time the potential energy transfer from a source; it is not interrupted once equilibrium is reached, and the mold, i.e., the grid voltage, continues to be modified. The transfer is almost instantaneous, and there is never a need to pause for demolding because the flow of the energy carrier is equivalent to a continuous demolding process; a modulator is a continuous temporal mold. (SIMONDON, 2005 [1958], pp. 46–47, translation added).

Beyond the reflective-conceptual approach involving Simondon's philosophy with the concept of *modularities* presented above, we also seek a practical-creative application, which means composing pieces based on the conception of interconnections, modulations, and modules. The focus is on how these objects, whether physical or digital, communicate and create sonic and visual transformations. Next, as part of this kind of artistic laboratory, we will use the ideas presented here reflected in the piece *"Entre Máscaras (2023)"*.

Creative Process

Both the piece and the conceptual reflections presented here are part of a doctoral music research specializing in sonology at Universidade Federal de Minas Gerais. The creative process was inspired by Ingmar Bergman's film "Persona (1966)". In this psychologically driven work, the director explores the personality conflicts of an actress who chooses to remain silent and a nurse who accompanies her in some kind of psychiatric hospital. In the film, one of the characters reflects: "Is it possible to be one and the same person at the very same time?" (at 34:28 minute). Based on this question, we sought to explore the concept of different personas that can emerge from a single individual, represented here by the cello.

Thinking in terms of blocks and connections instead of traditional musical structures can be a constant in the creative flow of interactive music, as it integrates clearly and comprehensively all the instruments, techniques, concepts, and codes used in a performance, composition, or music creation process.

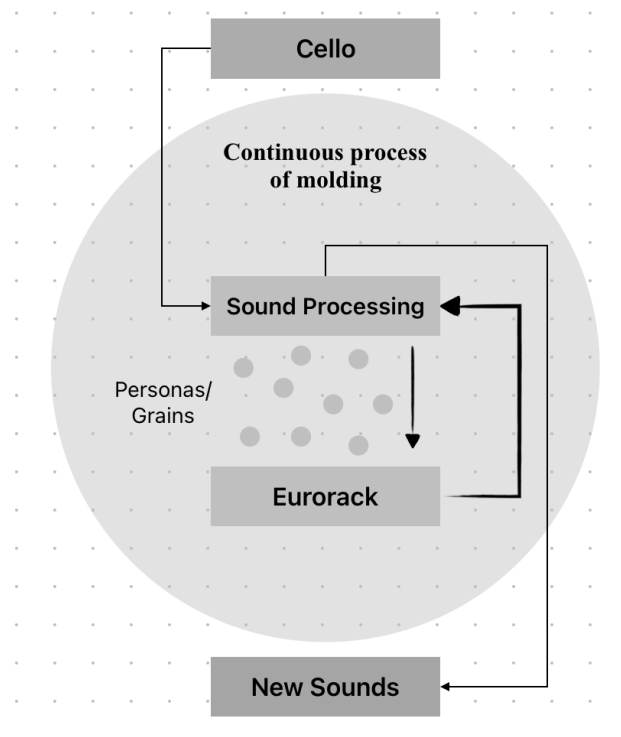
Composer and researcher Marije Baalman detail in her book *Composing Interactions* (BALLMAN, 2022) that in the analysis and creation of interactive projects, there are at least three stages: the first is to understand what the artist intends to achieve with their work; then, based on this conception, to look for physical components and how they can be interconnected; and, finally, to understand a pattern of connections and other processes that will be carried out.

[...] we look at what is there, what are the physical components, how are they connected to each other, what software is used, and how the connections are made in software. Finally, we follow the signal paths: how are the data processed, manipulated, and molded to affect the output medium? with this method, we start at the concept and the (intended) experience, and then dig deeper and deeper into the implementation (BAALMAN, 2022, p. 29).

When faced with the possibilities within the context of interactive music, where the abundance of devices, codes, and software opens up a wide range of techniques and sonic outcomes, it is interesting to first consider the aesthetic and poetic objectives, as well as evaluate what is available to ensure the realization of these initial intentions in musical creation.

For the piece *Entre Máscaras*, our poetic purpose was to process and modulate the sound of the cello to create sonic responses that represent the idea of multiple personalities. The poetic and conceptual processes are aligned based on the concept of transduction and mediation by Simondon. In a practical way, the signal flow that is modulated by the granulator, fragmented into small pieces to generate impulses in other instruments, and then returns to interact with the same sound that initiated the entire process, can precisely represent the idea of a chain of *modularities*, where the result is new sonorities that constantly transform and intermodulate.

Figure 1 - Modulation process



Source: Personal file (ROMAGNA, 2023)

In another aspect, the idea of using a modular conception guarantees us a constant technical and aesthetic challenge of restructuring. The act of connecting and disconnecting cables, analog or digital patches, and codes can consistently generate new creative processes in both creation and composition, as well as in the performance of interactive music. Collins

(2003), in a case study of the duo "Slub," comments that "[...] destructive reworking of patches and the entering of illegitimate code is in itself the process of composition."

For this reason, in *Entre Máscaras*, our first exercise was to create a kind of operational score and creative flowchart, indicating our poetic intentions and providing a technical description of what was available. We will detail this process further in this work. In a second stage, we sought cello samples close to the intended sound to perform tests with the granulator and *amplitude-based slice* to generate effective responses in the analog modular system. Only after this experimental exercise did we begin conceiving the musical form of the piece. In this sense, the exploratory study of patch creation and the interconnections in both the eurorack¹ system and Pure Data greatly influenced our technical and creative decisions in defining a performance plan.

Structure

The piece was initially developed for cello, Pure Data, and an analog modular synthesis system, but it can also be adapted for software such as VCV Rack². As the first cello notes sound, a series of interactions occur between the modular system and Pure Data to bring forth other sounds that symbolize different personas that can be assumed through the cello's performance. Various audio processing and synthesis techniques are employed, as we will see next. However, it is essential to emphasize that these techniques aim to represent the idea of *transduction* and *modularity*, and how they intertwine with the poetics of the piece.

The electronic part of *Entre Máscaras* was programmed as a patch in the Pure Data musical computing environment and consist of three types of audio processes: granular synthesis, reverse grains, and amplitude-based audio slicing, using the library FluCoMa³. The piece uses first and second-order ambisonics using IEM Plug-in Suite⁴. The signal input and output configuration include one microphone input (capturing the cello), four inputs from the modular system, four return outputs to the modular system, and the main output in ambisonics.

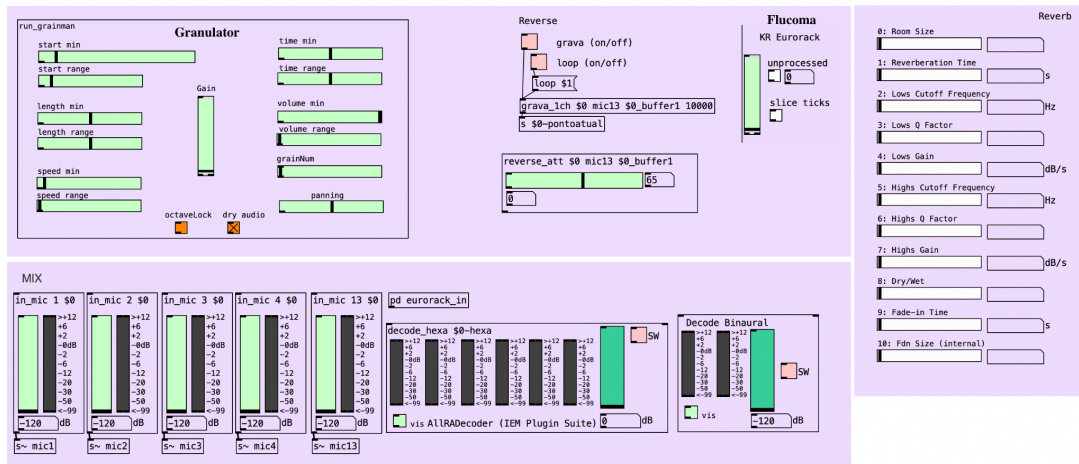
¹ Eurorack is a modular synthesizer format originally specified in 1995 by Doepfer Musikelektronik which is basically a miniaturized version of the original formats used in the 60s and 70s by Moog and Roland.

² VCV Rack is software based on an unreleased C++ modular audio engine written by Andrew in 2012. Available at: <https://vcvrack.com>. Access on: July 19, 2023.

³ Project Fluid Corpus Manipulation. Available at: <https://www.flucoma.org/>. Access on: July 19, 2023.

⁴ Available at: <https://plugins.iem.at/>. Access on: July 19, 2023.

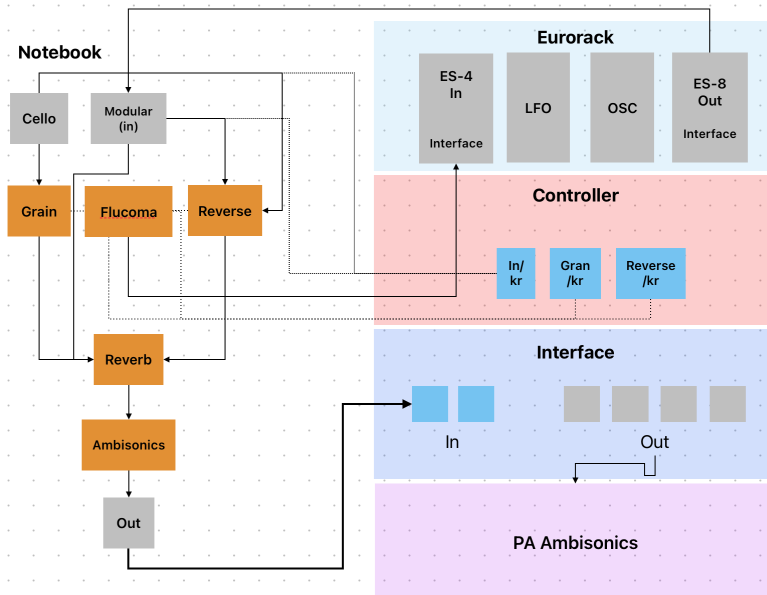
Figure 2 - Pure Data main page



Source: Personal file (ROMAGNA, 2023)

The signal flow occurs through the input capture of the cello, which is processed in real time by a granulator and an [fluid.ampslice~]⁵ that, in turn, generates impulses functioning as triggers for modules in the modular system. The sound from these modules is sent back to the patch in Pure Data and processed by the reverse (abstraction that records a

Figure 3 - Operational Diagram



Source: Personal file (ROMAGNA, 2023)

⁵ Available at: <<https://learn.flucoma.org/reference/ampslice/>>. Access on: July 19, 2023.

sample of the input audio in real-time plays back short slices of audio in the reverse), creating a dynamic of delay and a less pronounced response to the cello sounds.

The analog modular system features an audio interface (four inputs and eight outputs) that connects to the laptop via a USB port for signal sending and receiving. Initially, the process involves sending signals from PD to the interface, which connects to a VCO module⁶. The generated impulses are also used as a clock for an LFO module⁷ that will divide the signal for other parameters, both from VCO and other available modules. The idea is to allow an improvisation environment with some VCO and effects modules available in the system. This configuration can be perfectly replicated in the *VCV Rack* software with freely available modules using OSC messages or other arrangements.

In these *intermodulation* processes, our aim was to make the sounds of the eurorack respond to the stimuli and amplitude variations of the cello, giving rise to the concept of multiple personalities. The granulator aims to fragment the sound into small sound particles, which can represent a disintegration of the main personality into multiple personas. The reverse brings the idea of temporal volatility in which these personas appear and are evoked by the stimuli of the Cello. For this reason, we chose to use an ambisonics system to create a spatial context where we can identify the different sound responses that represent the other personas from the Cello at different listening points in the room. The various personas (produced by the eurorack and Granulator) also symbolize the interaction processes that occur between the acoustic instrument and the electronic and digital systems. In this sense, as in Simondon's process of transduction, signals inform other signals, creating new sounds/information/personas.

The entire creative process also required a planning and writing approach that differs from conventional scores; for this reason, we will now present some other strategies used, in addition to those already mentioned above, which aided in the development of the piece.

Writing

The piece *Entre Máscaras* has a character of guided improvisation and does not rely on traditional sheet music. However, even though unconventional in the context of concert music, writing is present from the poetic and conceptual planning of the piece to its execution,

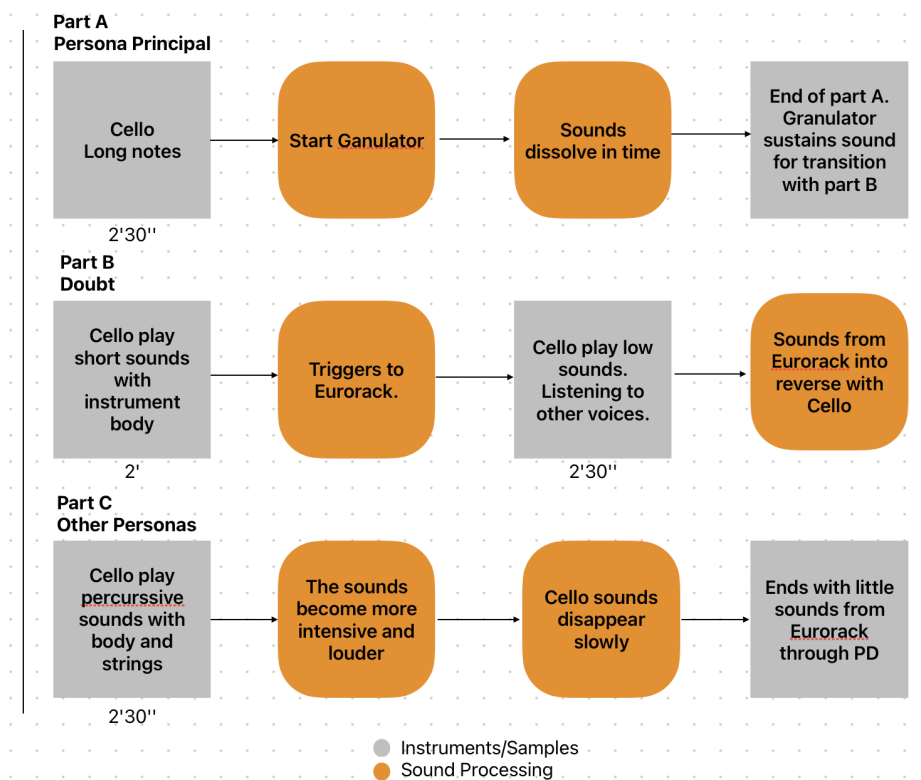
⁶ *Plaits* from *Mutable Instruments*

⁷ *Maths* from *Make Noise*

providing relevant information regarding signal flow, musical form, operational maps, and the arrangement of instruments and objects.

During the creation process, the first type of writing developed was what we refer to as an operational diagram (figure 3) and a musical form diagram, which is essentially a visualization of the systems, objects, patches, and instruments that will be used, as well as defining the signal flow for the entire performance. Both diagrams function as a sort of musical score for the piece.

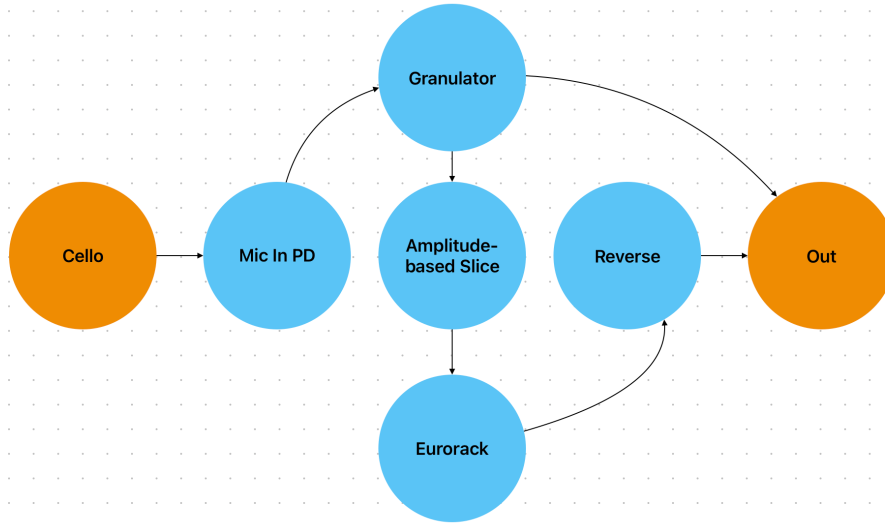
Figure 4 - Musical form



Source: Personal file (ROMAGNA, 2023)

In addition to the operational score, we also developed a conceptual diagram for the modular processes, or *modularities*, of the creative part of the piece. Although they may appear similar, this type of writing is much more closely aligned with the creative process than a structural approach. In this score, we made it clear that our intention was for the interconnection processes in the piece to follow an intermodular logic, reinforcing the conceptual basis of Simondon's theory of transduction.

Figure 5 - Conceptual diagram



Source: Personal file (ROMAGNA, 2023)

The writing becomes open and proactive but does not prevent using traditional sheet music. We propose an expansion of possibilities and ways to systematize creative thinking, as well as technical structuring in interactive music that a musical staff alone cannot represent. Once again, we can observe the concept of *modularities* in guiding musical planning, both from a technical and creative perspective. The processes of connections, modulations, and intermodulations in interactive music attain the same level of importance as melodic and harmonic knowledge in romantic music. In this sense, considering signal paths can be analogous to the reasoning of harmonic cadences in traditional Western music, but not in technical terms. It is not our goal to draw a parallel between these two distinct creative processes but to demonstrate how modular conception reaches a particular pattern and systematization in interactive music, and how this knowledge can lead us to a new musical paradigm for current practices.

Final Remarks

When observing the interconnections between objects, instruments, sound sources, transducers, and different types of technical objects, interactive music and arts lead to the emergence of a modular paradigm in creative processes. In general, these creative approaches

operate through dynamic interconnections between the different modules at play. On the other hand, the structures created by these interconnections are networks in which diverse signals are either modulated or act as modulators, resulting in a continuous shaping of sounds, images, and whatever else these signals represent. In addition to being mere technical substrates, the modules and patches of voltage-controlled synthesizers and those of interactive music computing environments also give rise to new ways of thinking about musical creation, human-machine interactions, and creative processes involving technical objects.

The concepts presented in this work were used for both a reflective-conceptual and practical-creative approach. In this sense, the process of creating the piece *Entre Máscaras* was mediated by a perspective that we call *modularities*, as well as the concept of *transduction* developed by Simondon. In a way, this also served to exemplify how the logic of *modularities* is present in the initial conception of a piece, during the creative process, and in writing as well. This work is an initial step towards systematizing this modular perspective in the field of music and interactive arts, highlighting the specificities of technical-artistic creations that rely on interconnected modules and signal intermodulation processes.

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