

MNT2: A Longitudinal Evaluation of an Open-Source Mapping Software

MNT2: Uma avaliação longitudinal de um software de mapeamento de código aberto



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Abstract: El mapa no es el territorio (henceforth MNT) is an open-source application developed to control synthesizers and audiovisual materials through gestures. It was designed by the author to consolidate strategies involved in creating interactive installations and audiovisual environments for performances. It offers six interconnectable modules, each centered around a different two-dimensional map. These maps feature different approaches to mapping gestures to synthesis parameters, including graphical interpolation and corpus-based concatenative synthesis. They can be configured manually or rearranged through dimensionality-reduction techniques. This article briefly introduces MNT2 and focuses on its evaluation process. It reviews literature on the evaluation of new musical interfaces, discussing both longitudinal and practice-based approaches. These approaches were used to design a study in which five experienced musicians and sound artists used MNT2 over several weeks, integrating it into their workflows and creative practices. In the final stage of this process, they were asked to compose a piece using MNT2 and participated in semi-structured interviews. Finally, the article presents the results of this evaluation.

Keywords: Mapping, gesture, longitudinal evaluation, practice-based, unsupervised learning

Resumo: El mapa no es el territorio (doravante MNT) é uma aplicação de código aberto desenvolvida para controlar sintetizadores e materiais audiovisuais por meio de gestos. Foi concebido pelo autor para consolidar as estratégias envolvidas na criação de instalações interativas e de ambientes audiovisuais para performances. Oferece seis módulos interconectáveis, cada um centrado em um mapa bidimensional distinto. Esses mapas apresentam diferentes abordagens para mapear gestos em parâmetros de síntese, incluindo técnicas como interpoladores gráficos e síntese concatenativa baseada em corpus. Eles podem ser configurados manualmente ou reorganizados por meio de redução de dimensionalidade. Este artigo apresenta brevemente o MNT2 e concentra-se no seu processo de avaliação. Ele analisa a literatura sobre a avaliação de novas interfaces musicais, discutindo abordagens longitudinais e baseadas na prática. Essas abordagens foram usadas para projetar um estudo no qual cinco músicos e artistas sonoros experientes usaram o MNT2 durante várias semanas, integrando-o aos seus fluxos de trabalho e práticas criativas. Na fase final desse processo, eles foram convidados a compor uma peça com o MNT2 e a participar de entrevistas semiestruturadas. Por fim, o artigo apresenta os resultados dessa avaliação.

Palavras-chave: Mapeamento, gestos, avaliação longitudinal, baseado na prática, aprendizagem não supervisionada

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1. Introduction

MNT¹ is an open-source application developed by the author. It allows the user to control synthesizers through physical movements by creating mapping schemes based on two-dimensional maps (Figure 1). One of the main interests behind MNT is the collective design of audiovisual materials in projects involving digital instruments or interactive audiovisual environments.

Figure 1 - Mapping



Source: Created by the author

Description of the image: illustration of a mapping scheme using MNT2.

MNT was initially developed to share mapping strategies with musicians and video artists who have neither a strong interest in programming nor in the more technical aspects of such projects. To this end, MNT compiles techniques that do not require extensive training or calibration, prioritizing a creative approach grounded in play and exploration. It can be applied to controlling synthesizers, DAWs, VJ software or any general-purpose tool developed by third parties. The project has received funding from UNQ and UCLA REMAP and was awarded first prize in the art and technology competition Fusión 2020. It was presented as one of the main outputs in the author's PhD thesis at Universidad Nacional de las Artes.

The first version of MNT2 was developed in 2018 in cheLA, for the interactive audiovisual system used in the dance and circus piece Recorte de Jorge Cárdenas Cayendo. This practice-based approach became a guiding principle for the project. Tools were only added when required for specific artistic outputs. MNT2 was driven by the need to solve problems

¹ <https://mnt.com.ar/>

related to creative projects and exhibitions, with modules like Concatenate evolving from various performances and installations developed between 2017 and 2022. This approach provided frequent validation opportunities through public presentations and academic discussions, while ensuring that artworks were not treated as mere testing grounds for pre-conceived tools.

Although it was designed to control audiovisual materials in interactive environments, MNT2 has led to new uses over the years. In particular, it has been used extensively to produce sound materials in studio settings and without the intervention of sensors. An evaluation process was designed to validate the potential of these emerging uses.

This article focuses on this evaluation process. It will review problems and particularities of evaluating tools aimed at designing digital musical instruments. It will then briefly present the characteristics of MNT2. Finally, it will describe the evaluation process and discuss its results.

2. Related work

2.1 Mapping software and strategies

Digital musical instruments (DMI) can be understood as systems composed of multiple software and hardware devices. Traditionally, at least three basic components are distinguished: an input device that captures a performer's movements, a sound synthesis engine, and a subsystem that translates gestural information into musical information (Miranda and Wanderley, 2006; Tanaka, 2009). The design of gesture-sound relationships, particularly important for MNT, has been a central research topic since the earliest interactive digital instruments. In specialized literature, this relationship is commonly formalized as mapping. Hunt and Kirk (2000) proposed a terminology for analyzing mapping schemes that

distinguishes between explicit and implicit strategies. Explicit strategies involve connections between parameters that are determined directly, whereas implicit strategies -sometimes referred to as generative strategies- employ an intermediate model to construct these relationships.

One approach to constructing models for implicit strategies is to use interpolation techniques. Examples include Colorblobs, Metasurface, and Intersecting n-Spheres. Colorblobs (Momeni and Wessel, 2003) uses a set of Gaussian kernels to represent and modulate musical materials as combinations of synthesis parameters or samples. Metasurface (Bencina, 2005) is a control interface for the AudioMulch software that uses natural neighbor interpolation to gradually modulate between sets of parameters. Intersecting n-Spheres (Marier, 2012) represents both interpolation points and presets as circles; the resulting parameters depend on the intersection of these circles.

Machine learning techniques constitute another widely adopted approach in DMI design. Most cited applications and libraries focus on supervised learning, in which algorithms build models of the relationship between input and output from labeled examples. Wekinator (Friebrink, 2011), for example, implements many of Weka's methods. The Gesture Recognition Toolkit (Gillian and Paradiso, 2014) provides a wide range of classification and regression algorithms. Gesture Variation Follower (Caramiaux et al., 2014) is a gesture-recognition system that, in addition to classification, supports the characterization of movement execution.

Unsupervised learning remains less explored in the design of mapping schemes. Examples include SOMba (Ness and Tzanetakis, 2009), a system that generates rhythms in response to the trajectories of multiple users. Unsupervised play (Smith and Garnett, 2012) explores this approach through a Max library that supports self-organizing maps (SOM), among other tools. Cartwright et al. (2014) designed an interface based on SOM that provides a two-dimensional control surface for mixing in

digital audio workstation environments. One of the most widely used dimensionality reduction techniques in audio today is t-Distributed Stochastic Neighbor Embedding (t-SNE, van der Maaten and Hinton, 2008). Although numerous examples can be cited (Benjamin and Althosaar, 2015; Font and Bandiera, 2017; Lionello et al., 2018; Shier et al., 2021), one of relevance for this article is AudioStellar (Garber et al., 2020), as some aspects of the MNT2 analysis script are based on this application.

2.2 Longitudinal Evaluation of Digital Musical Instruments.

Practices related to the evaluation of digital instruments and interactive systems for music production have been extensively examined, particularly in recent years (Barbosa et al., 2015; Brown et al., 2017; Stowell et al., 2017). The strategies applied in communities dedicated to new instrument design often differ in methods, objectives, and even in the interpretation of the word “evaluation” (Barbosa et al., 2015). Conceptual frameworks have been proposed to unify criteria and offer systematic approaches to this task (Schmid, 2017). Some of these frameworks incorporate approaches from UX and other disciplines (Reimer; Wanderley, 2021). However, there are still no clearly defined guidelines for methodological design.

A recurring factor in explaining the dispersion of criteria is the idiosyncratic nature of the interfaces and instruments being evaluated. Designers often avoid developing controllers or interfaces that resemble existing instruments (Young; Murphy, 2015). Some devices, moreover, arise to solve some specific need of a composer or performer, or even for use in a particular piece. This poses a problem when choosing evaluation parameters, particularly because it necessitates considering the contexts and users for whom the devices were developed (Wanderley; Orio, 2002). These interfaces can also be conceptualized in many ways, presenting themselves as instruments, input devices, parameter mapping schemes, output devices and other similar configurations.

On the other hand, these technologies reconfigure traditional relationships in music, creating intersections and overlaps in the perspectives from which evaluation is performed. Some roles that recur in the literature are audience, performer, designer and maker (Morreale et al., 2014). Each of these roles implies a different approach to evaluation. For instance, in a review of papers published in the NIME conference proceedings, Barbosa et al. (2015) classified evaluation processes according to three perspectives: audience (20%), performer or user (52%), and designer (28%). These approaches influence methodology, as quantitative methods often dominate evaluations focused on the designer's perspective, which are commonly concerned with technical aspects. When the user experience predominates, on the other hand, qualitative methods such as interviews or questionnaires are usually used.

Methodologically, interactive systems for music production challenge traditional techniques for evaluating human-machine interaction. Because they involve creative and affective aspects, musical interactions cannot be described as tasks with measurable completion rates. The attention required for their use and the need for temporal precision render certain traditional techniques intrusive, such as protocols based on speaking aloud while performing a task. Other methods, such as participant reaction observation, face challenges due to the lack of clear success criteria and the varying degrees of bodily involvement in performance. Studies are usually conducted with a limited number of subjects, due to the specific skills required. This makes the use of psychometric scales difficult (Stowell et al., 2009).

Another important aspect to consider is the duration and context of these studies. According to Barbosa et al. (2015), most evaluation processes presented at the NIME conference (66%) took place in a single session or experiment. This characteristic appears to stem from the skills needed to use these devices effectively. However, many frameworks propose observing both

how devices are used in practices outside the laboratory and the learning process required to use them (Reimer; Wanderley, 2021; Gelineck; Serafin, 2012; Jordá; Mealla, 2014).

There are few studies conducted from the user's perspective over long periods of time and outside workshops or laboratories. Brown et al. (2018), for example, examine the mapping practices of experienced users, while Gelineck and Serafin (2012) propose a longitudinal evaluation of a novel interface. The latter highlights two reasons for choosing a longitudinal approach to evaluating interactive systems. On the one hand, this strategy is useful for accounting for changes in usage over time. On the other hand, it makes it possible to explore how a device can integrate into a user's habitual practices, and how it can articulate with other tools. Conducting evaluation processes outside the laboratory helps avoid interference with practices often tied to specific spaces and schedules, as is common in computer music production.

Gelineck and Serafin (2012) evaluated, as a case study, the PHOXES interface, a modular set of musical instruments based on physical modeling developed specifically to test the proposed methodology. The evaluation lasted four weeks, divided into three phases. In the initial two-week phase, users were offered a free exploration of the interface. In the second phase, lasting one week, specific compositional tasks were proposed to encourage the exploration of features neglected by the subjects in the first phase. Finally, an additional week was dedicated to a new free exploration process. After each phase, semi-structured interviews were conducted. During these interviews, participants were asked to demonstrate how they used the interface. The analysis of the results was carried out following the guidelines proposed by Kvale and Brinkmann (2009) and Johnston (2011).

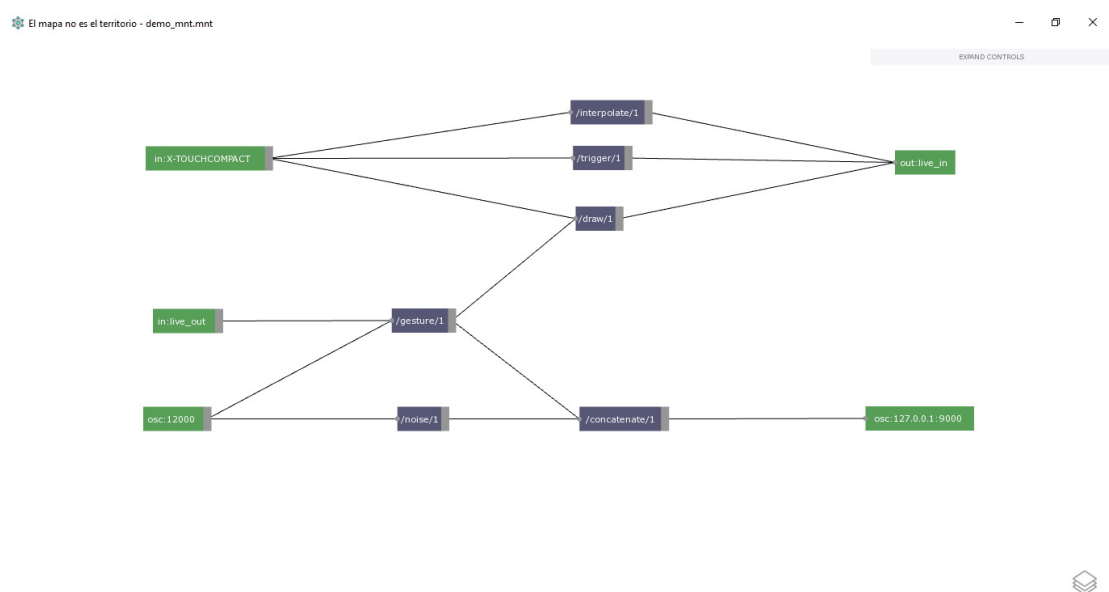
3. MNT2

MNT2 is an open-source application that allows users to create mapping schemes by interconnecting six modules. As this article focuses on the evaluation process, this section provides a brief overview of the graphical interface, the modules, and the machine-learning techniques available for rearranging the maps within the modules. A full description of the project, including the design methodology and implementation details, is provided in Sguiglia (2025).

3.1 Graphical Interface

MNT2's main visualization is a diagram-based graphical interface, referred to as the "connection view" (Figure 2). MNT2's connection view makes it possible to configure "sets": combinations of modules, inputs, outputs and connections. By double-clicking on the rectangles that represent the modules, the user can access the "edit view" (Figures 3, 4, 5, 7 and 8). This view displays specific configurations for each module. The "tiled view" (Figure 10) shows all modules in a set at once.

Figure 2 - Connection view



Source: Created by the author
Description of the image: screen capture of MNT2's connection view.

3.2 Modules

MNT2 includes six modules: Interpolate, Concatenate, Trigger, Draw, Gesture and Noise. They can be connected to each other or to inputs and outputs. Each of these modules is structured around a two-dimensional interface or map. In the Interpolate, Trigger and Draw modules, the maps contain combinations of parameters or presets. In Concatenate, points represent audio files or fragments of audio files. Finally, the graphics included in Noise and Gesture represent cursor positions or trajectories. All modules send and receive messages either via MIDI or OSC.

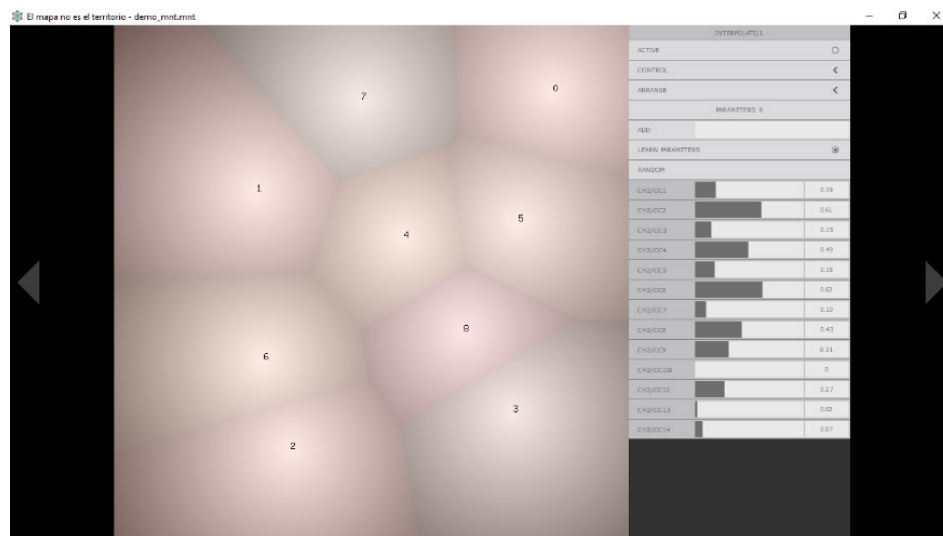
3.2.1 Interpolate

Interpolate (Figure 3) was inspired by Metasurface (Bencina, 2005). It uses natural neighbour interpolation (Sibson, 1981), a method based on Voronoi tessellation, to generate gradual transitions between presets assigned to polygons (zones) distributed across a map. When navigating the interpolation space, a new polygon is inserted at the cursor position. The weight of each preset in the resulting parameter set is determined by the area that this new polygon takes from the existing ones.

This module can be used to smoothly transform timbres and textures, as long as they can be understood as collections of parameters. A zone may represent, among other things, a synthesizer sound or a mix in a DAW. If the cursor is placed at the center of a zone, the module outputs the exact parameter combination stored in that zone. As the user moves through the map, different sonic materials emerge from the merging of multiple presets.

As an illustrative example, one of the earliest uses of this module was in the dance performance *Recorte de Jorge Cárdenas Cayendo* (2018-2020). In this piece, different soundscapes were distributed across the stage, allowing performers to recall and transform them as they moved through space.

Figure 3 - Interpolate

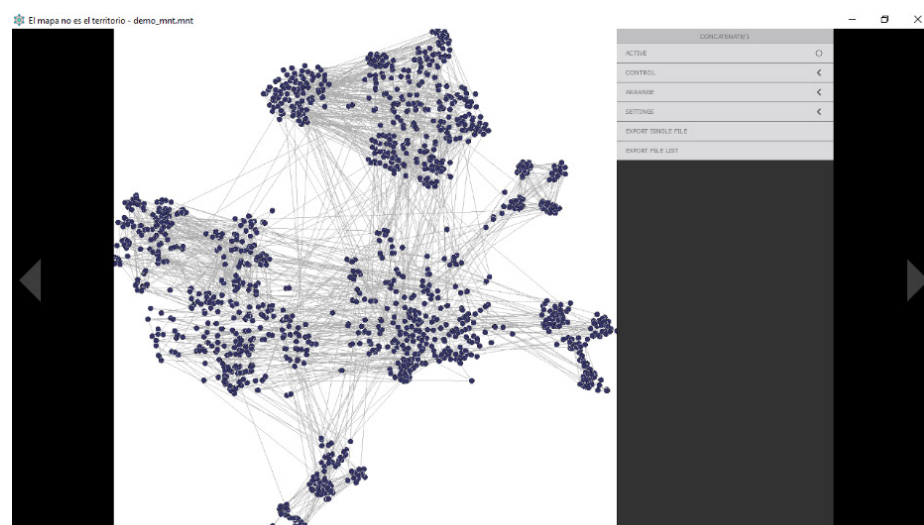


Source: Created by the author
Description of the image: screen capture of MNT2's Interpolate module.

3.2.2 Concatenate

Concatenate was designed to control corpus-based synthesis (Schwarz, 2007). It analyzes audio files, extracting 19 Mel-frequency cepstral coefficients (MFCCs) and a set of audio descriptors. It allows the user to generate a map by applying dimensionality-reduction techniques such as PCA or t-SNE (van der Maaten; Hinton, 2008) to the MFCC data, or by mapping selected audio descriptors to each axis.

Figure 4 - Concatenate



Source: Created by the author
Description of the image: screen capture of MNT2's Concatenate module.

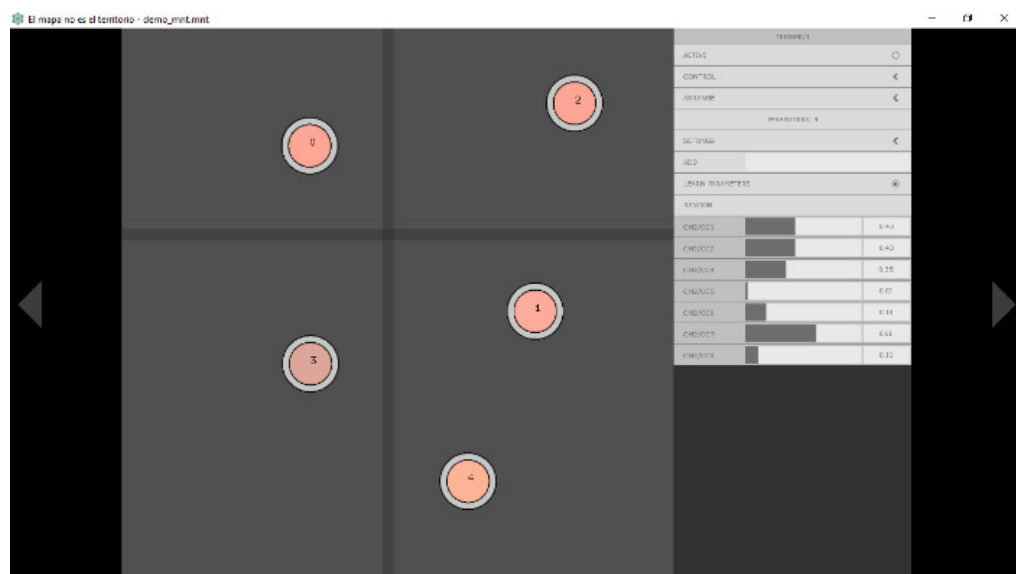
The map (Figure 4) displays points (“units”) that represent positions within audio files. When the cursor navigates the map, the module sends the file names and time positions of the selected units via OSC.

Concatenate allows the user to create granular textures or rhythmic patterns based on large collections of sound files. Among other things, it addresses a recurring problem in granular synthesis: avoiding discontinuities caused by differences between source sounds. Using the analysis features of the module, folders containing thousands of samples can be explored. The resulting map arranges these samples (or fragments of samples) according to a descriptor (e.g., low to high pitch from left to right) or through machine-learning techniques. In the simplest case, these techniques group similar sources into clusters: for example, motors and drums in one region of the map, whistles and birds in another.

3.2.3 Trigger

Trigger represents combinations of parameters through a series of objects distributed across a two-dimensional map. These “triggers” consist of two concentric circles with a configurable radius (Figure 5). When the cursor enters the inner circle, the trigger is activated, sending the stored values to the module output. A trigger is deactivated only when the cursor moves outside the larger circle. This prevents the preset associated with each point from being repeatedly triggered when the module is controlled by a noisy signal.

Figure 5 - Trigger



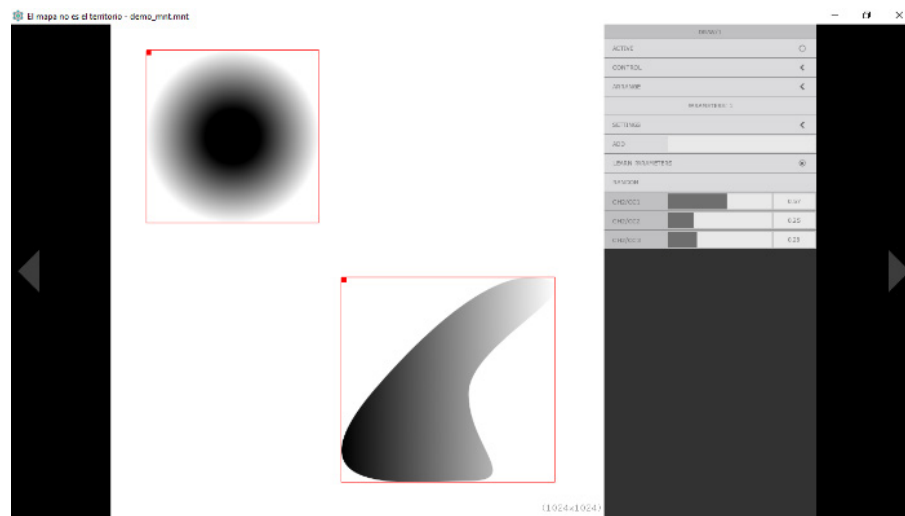
Source: Created by the author
Description of the image: screen capture of MNT2's Trigger module.

This is one of the simplest modules in MNT2. It allows for straightforward and playful interaction schemes: one action, one result. As an illustrative example, one of the earliest uses of this module was in the installation Huerta Hipermedial (2014). In this work, visitors could navigate a generative soundscape in response to their movements around a hydroponic garden. The module was used to provide one of the first responses visitors encountered, triggering short samples when they touched a plant.

3.2.4 Draw

Draw aims to generate gradual transitions between parameter combinations using arbitrary graphics. It allows the user to work with grayscale images. At each cursor position, a single grayscale value is obtained by applying a Gaussian kernel. This value scales the values stored in the presets for each parameter. For example, moving the cursor to the center of the circle in Figure 6 could result in a fade-in.

Figure 6 - Draw



Source: Created by the author
Description of the image: screen capture of MNT2's Draw module.

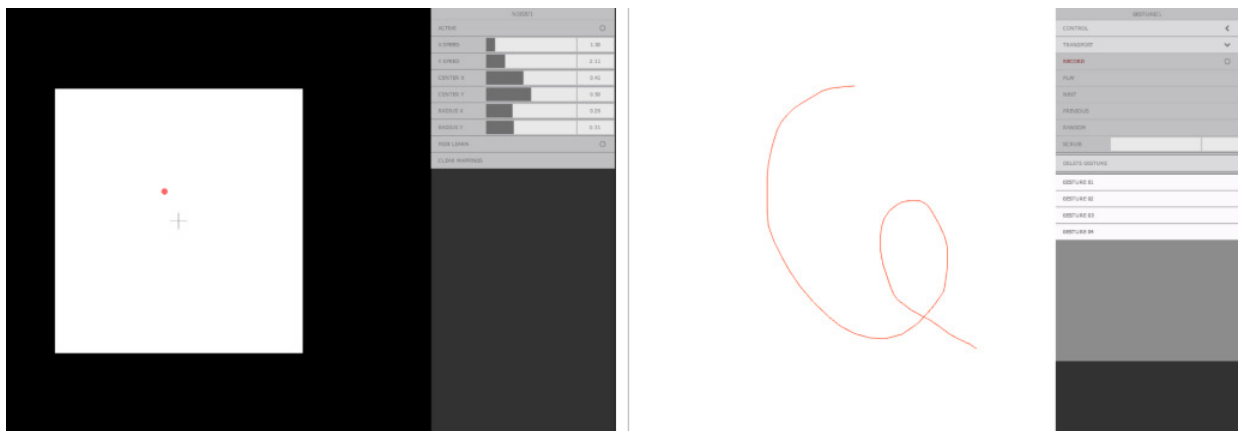
Draw produces results similar to those of Interpolate. The ability to draw zones instead of relying on polygons makes this module useful for mapping sound onto irregular surfaces. In the interactive installation *Memorias Migrantes* (2016), for example, audiovisual materials were assigned to different regions of a carpenter's table. These regions were defined according to the types of markings present, such as traces of handwork or water damage. A module such as Draw can address this kind of situation, as zones can take any form; in this scenario, the user could simply draw directly on top of an image of the table.

3.2.5 Gesture and Noise

Although they can be connected directly to outputs, Gesture and Noise were developed primarily to control the other modules. Gesture (Figure 7, right) captures and replays paths recorded by the user, while Noise (Figure 7, left) generates random trajectories using Perlin noise.

Using these modules, users can store gestures, generate them procedurally, or produce subtle variations by applying small amounts of noise to the cursor position.

Figure 7 - Noise and Gesture



Source: Created by the author
Description of the image: screen capture of MNT2's Noise (left) and Gesture (right) modules.

3.3 Data entry and analysis tools

In the Interpolate, Trigger, and Draw modules, both the positions of points and the parameter combinations they represent are initially defined manually. Once a map contains sufficient information, MNT2 allows the user to generate new points at random positions; the parameter values at these points are obtained by interpolating from the parameter values stored in existing presets. Preset positions may also be randomized, and maps redistributed by animating the trajectories of individual points. In addition, maps can be rearranged using descriptor-based methods and dimensionality-reduction techniques, as in the Concatenate module.

These operations can be understood in terms of movement within a parameter space. A set of continuous control variables defines a subset of an n -dimensional Euclidean space, in which each possible combination of variables corresponds to a point. From this perspective, actions on the controller may be interpreted as trajectories in this space, and mapping as the association between an n -dimensional control space and an m -dimensional synthesis space (Van Nort, 2010). Dimensionality-reduction techniques make it possible to project

multidimensional data -such as presets- into lower-dimensional spaces -such as maps- while preserving, as far as possible, the structure of the data. In practice, this means that presets that are close in a high-dimensional space tend to remain close after projection, enabling representations that facilitate smooth transitions between textures.

Following this approach, MNT2 uses t-SNE and PCA to generate alternative spatial distributions for maps. Points may also be ordered according to the value of a selected parameter. For example, the cutoff frequency of a filter -associated with a control-change message in a DAW and stored as part of a preset in MNT2- can be arranged to increase from left to right across the map.

4. Evaluation.

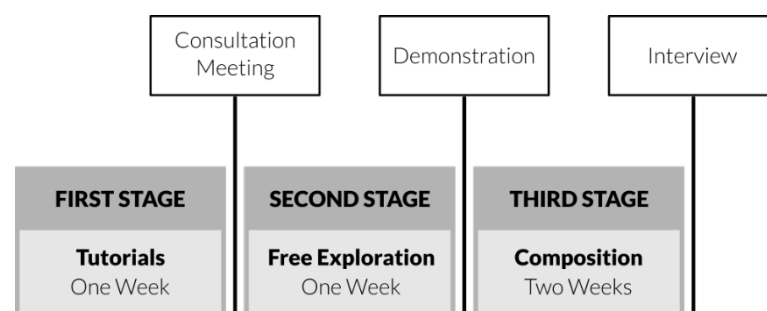
MNT2 was first designed to control audiovisual materials in interactive environments. However, during its development process, it was used extensively to create sound materials in studio settings and to control live performances. This practice resulted in the inclusion of new modules and in updates to the graphical interface and connection schemes. The evaluation process focused on analyzing these emerging uses.

One of the main interests behind the evaluation was to investigate user experiences, in order to assess whether MNT2 was received as an intuitive system that could be adopted by composers and performers of computer music. The utility of the available connection formats, the stability of the system, and the applicability of the technologies implemented in the sound design were evaluated as a secondary objective. The modules in MNT2 are based on previous developments and were incorporated to reflect concrete practices. In this sense, they were extensively tested in performances and installations.

4.1 Methodology

The evaluation of MNT2 was modeled on the framework described by Gelineck and Serafin (2012). A study was set up in which five participants used MNT2 in their usual work contexts. Participants were selected based on their experience. Priority was given to individuals who frequently develop unconventional mapping schemes for composing computer music or who work in the design of interactive or generative sound environments. The evaluation process was divided into three stages, for which minimum tasks and durations were assigned (Figure 8). To accommodate the evaluators' usual schedules and spaces, they were able to pause and resume tasks at their convenience.

Figure 8 - Evaluation of MNT2



Source: Created by the author
Description of the image: Evaluation schedule.

At the beginning of the evaluation, participants were provided with the application, a manual and video tutorials². During the first stage, lasting at least one week, they were asked to study these materials. At the end of this week, a consultation meeting was held to address any questions about the application's mechanics. In the second stage, participants were asked to freely explore MNT2 in sessions lasting at least one hour, focusing on familiarizing themselves with its features. Following this stage, participants attended a meeting to demonstrate how they used MNT2 and to explain the initial control schemes they had designed. The third stage spanned

² Although the original tutorials are not publicly available, similar videos can be found at <https://mnt.com.ar/#tutoriales>

at least two weeks, during which evaluators completed at least two one-hour sessions to compose a small piece or study. At the conclusion of this last stage, participants attended a final meeting to present their designed schemes and the outcomes of the assigned tasks, followed by a semi-structured interview.

4.2 Evaluators

4.2.1 Evaluator 1

Evaluator 1 (E1) was born in Buenos Aires in 1981 and currently resides there. They hold a degree in Composition with Electroacoustic Media and a PhD in Social Sciences. They teach at various universities. They work primarily on sound pieces and video. Although they were familiar with the theory behind some of the techniques implemented in MNT2, they had never applied them in practice.

4.2.2 Evaluator 2

Evaluator 2 (E2) was born in Buenos Aires in 1994 and lives in Temperley, Lomas de Zamora. They are a musician with classical training on the clarinet and a degree in Music and Technology. They are a PhD candidate in Science and Technology. Their main area of work is ludomusicology. They teach audio for video games and are a sound designer. While they use digital technologies professionally to produce music, they had neither used tools similar to MNT2 nor had in-depth knowledge of its underlying technologies before the evaluation.

4.2.3 Evaluator 3

Evaluator 3 (E3) was born in Salta in 1988 and currently resides there. They hold a degree in Music and Technology and are currently pursuing a PhD in Science and Technology. Their main lines of study are the acoustics of spaces and the soundscapes of Argentina. They have not used applications for parameter mapping and sound control, such as MNT2. They were unfamiliar with the techniques implemented in MNT2 at the start of the evaluation.

4.2.4 Evaluator 4

Evaluator 4 (E4) was born in 1994 in Buenos Aires, where they currently reside. They are a composer and saxophonist; they hold a bachelor’s degree in Composition with Electroacoustic Media and have graduated as a saxophone teacher. As part of this practice, they used tools similar to MNT2 and are familiar with some of its technologies.

4.2.5 Evaluator 5

Evaluator 5 (E5) was born in the city of Buenos Aires in 1985, where they live and work independently as an electronic musician, music producer, and private teacher. They also work as producers in audiovisual and sound art-related projects. At the beginning of the evaluation, they used parameter-mapping tools and corpus-based concatenative synthesizers.

4.3 Results

4.3.1 Input and output devices

The evaluators used a range of input devices and synthesis engines (Frame 1). Parameter input for modules that work with preset combinations was performed through the text fields and sliders available in the graphical interface or via MIDI controllers.

Frame 1 - Devices

Evaluator	Input device	Cursor control	Synthesis engine
E1	-	Mouse and messages generated in Pure Data	Granular synthesis in Pure Data
E2	Pocket MIDI (Android app)	Pocket MIDI (Android app)	Concatenate for Max for Live in Ableton Live
E3	NanoKONTROL (MIDI controller)	Mouse and NanoKONTROL	Concatenate for Max for Live in Ableton Live

E4	Mouse	Mouse	Virtual Instruments in Ableton Live
E5	Elektron Digitakt (hardware synthesizer and MIDI controller)	Mouse	Elektron Digitakt

Source: Created by the author.

Description of the image: Devices used by the evaluators to create and control MNT2 and to produce sound.

E2 and E3 used MIDI messages, using the Pocket MIDI app on a smartphone and the NanoKontrol hardware controller, respectively. E4 used the MNT2 graphical interface for parameter input and E5 made use of the MIDI output from an Elektron Digitakt, the same synthesizer they used for sound generation. Finally, E1 did not include preset management modules in their project.

The synthesis engines also varied across evaluators. E2, E3, and E4 controlled virtual instruments within Ableton Live. While this is one of the most widely used digital audio workstations in recent decades, this decision may have been influenced by the tutorials, which featured examples developed through this DAW. Both E2 and E3 focused sound generation on the Max For Live device MNT::CONCATENATE, while E4 used Ableton Live's native devices. E1 developed a patch in Pure Data, centered around the `grainer~3` granular synthesis external. E5 controlled parameters on an Elektron Digitakt hardware synthesizer:

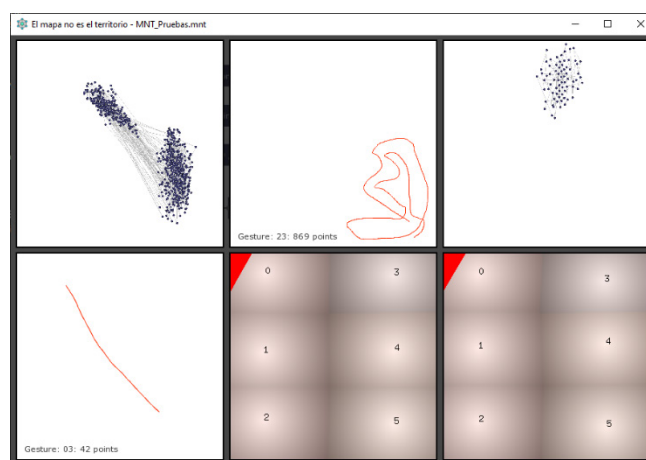
The sampler I use is an Elektron, which also functions as a MIDI controller, so I was working with MIDI from there (...) The sampler has eight channels, and all its parameters respond to control change messages. So, I selected a bank of parameters that includes the start and end points of the samples, the filter cutoff frequency, and effect sends like reverbs. These are the ones displayed in Interpolate. Then, using the analysis tools, I experimented with different configurations to explore various map organizations. With the Gesture module, I tried controlling Interpolate by creating drawings.⁴

³ https://github.com/odiliscia/the_grainer_PureData_gh

⁴ Interviews were conducted in Spanish; all translations are by the author.

For cursor navigation, E2 used the two-dimensional control included in Pocket MIDI ("XY PAD"). The other evaluators preferred to navigate representations by dragging the mouse cursor over the MNT2 interface. E3, in addition to navigating Concatenate through gestures, controlled two instances of Interpolate using a NanoKONTROL. They organized presets in a 6-row-by-2-column grid (figure 10).

Figure 10 - Tile view of E3's set



Source: Created by the author
Description of the image: Screen capture of MNT's Tile View.

They used a controller button to select columns and a slider to control vertical-axis positions. Finally, E1 stored trajectories created with a mouse in Gesture and controlled their playback using OSC messages sent from a Pure Data patch.

4.3.2 General characteristics of the sets

The evaluators designed sets that included between 2 and 6 modules (Frame 2). In all cases, they included one of the modules dedicated to generating or storing trajectories. However, no set included an instance of Draw. All projects centered on audio file manipulation rather than sound synthesis.

E1, E2 and E3 used Concatenate for this purpose. As noted in the previous section, E1 controlled a Pure Data patch implementing granular synthesis. E2 and E3 used the Max For Live

MNT::CONCATENATE device. The other two evaluators relied on different samplers. E4 used native Ableton Live instruments. E5 used samples stored in an Elektron Digitakt sampler and drum machine. The output obtained through these instruments was modified using additional audio processes, either integrated within these devices or as effects organized in return channels. Notably, no other synthesis techniques were employed in the projects.

Frame 2 - Modules

Evaluator	Number of modules	Modules	Main module
E1	6	Concatenate and Gesture	Concatenate
E2	5	Interpolate, Concatenate, Gesture, Trigger and Noise	Concatenate
E3	6	Interpolate, Concatenate and Gesture	Concatenate
E4	6	Interpolate, Trigger and Noise	Trigger
E5	2	Interpolate and Gesture	Interpolate

Source: Created by the author.
Description of the image: Modules used by the evaluators.

During the interviews, the evaluators noted that they had relied on one main module to drive their pieces. E1, E2 and E3 centered their work on Concatenate, using other modules to control parameters of MNT::CONCATENATE or of audio processes. E3, in particular, described MNT as a “complex granular synthesizer”:

I thought of MNT2 as a sound material creation system; in a way, I saw it as a sophisticated granular synthesizer, like a box where I put a bunch of information I had and then resynthesized it based on spectral data.

E4 and E5, on the other hand, relied on external synthesizers. Both evaluators used a single module to determine event occurrence, with E4 focusing on Trigger and E5 on Interpolate. In E4's case, additional modules were used to control supplementary processes. Interestingly, while E1, E2, and E3 predominantly work on digital environments, the two evaluators who preferred preset management modules (E4 and E5) favor hardware synthesizers. For instance, although E4 ultimately constructed their project using native Ableton Live samplers, their initial inclination was to work with a Volca Sampler:

My initial approach was to intuitively organize the sounds and load them into a Volca Sampler so I could control them with MNT2. I couldn't achieve an appealing setup, so I decided to work with a DAW instead.

4.3.3 Use of Modules

a) Concatenate

E1, E2 and E3 included at least one instance of Concatenate in their sets. Both E1 and E3 manually classified their audio files before analysis, including instances of Concatenation for sample groups. E1 distributed audio files in three instances of Concatenate. They edited the samples before analyzing them, selecting fragments they found interesting and removing redundant information:

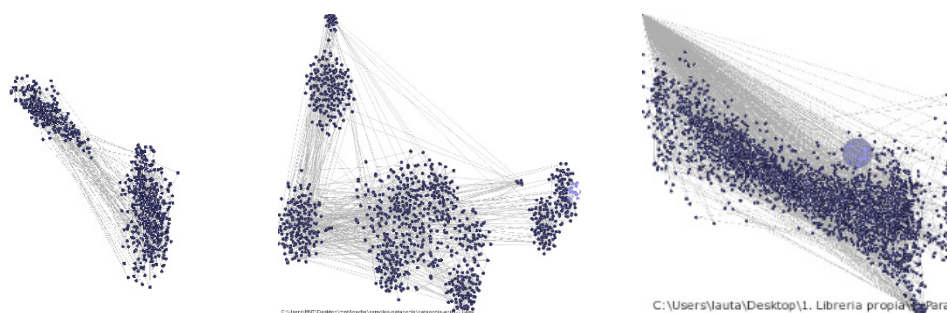
I devised a concatenative synthesis trio. The synthesis units are divided into three materials: rain, birds, and running water. I used the tools to distribute the maps and came up with three configurations that I liked. Each of these maps controlled a granular synthesis engine.

E3 used two instances of Concatenate. They pruned the maps by removing units, obtaining relatively small collections of points:

Down here [in Concatenate], I have sounds of soundscapes: birds, crickets, etc. Up here, there's an erquencho, deeper, raspier. I navigate this using gestures. When I move the cursor in Interpolate, it changes the period and grain size. This way, I can achieve more percussive, more 'granular' sounds, and, in other cases, more continuous ones.

E2, on the other hand, analyzed a folder where they routinely store samples, without considering its contents. Instead, they relied on Concatenate's analysis tools to cluster units.

Figure 10 - Use of Concatenate



Source: Created by the author

Description of the image: Screen capture of Concatenate configurations for E3 (left), E1 (center) and E2 (right).

b) Trigger and Interpolate

Except for E1, all evaluators included at least one instance of Trigger or Interpolate in their projects. As discussed previously, the importance of these modules varied across the sets. These differences can be observed in the number of presets distributed across the maps, and the number of parameters assigned to each preset.

E4 and E5, who placed particular emphasis on Trigger and Interpolate, used a large number of zones. While E4 distributed these zones across different modules, E5 centralized parameter control in a single instance of Interpolate. E5 also designed complex parameter combinations for each point on the map, involving many parameters.

E2 and E3 focused their projects on the Concatenate module, relegating Trigger and Interpolate to secondary roles. These modules were mainly used to modulate granular synthesizer parameters or apply audio processing to Concatenate's output. Compared to E4 and E5, E2 and E3 used fewer zones.

Both E2 and E5 used Interpolate's tools to organize their maps. E2 noted that they didn't necessarily need to understand the dimensionality reduction techniques to use them:

The most important thing was that I understood the sonic result. I mean, sometimes I'd come across things I didn't know I could achieve with the app, but once I heard it and tested it, I could replicate it and understand why it produced that result.

E3 arranged zones in a layout tailored to their controller's characteristics, rendering these tools impractical for their setup. Lastly, E4 did not find it useful to include Interpolate's organization tools in their project, as the presets contained a relatively small number of parameters.

c) Gesture and Noise

All the sets designed by the evaluators included at least one instance of Gesture or Noise. These tools served different roles in shaping the temporal development of their pieces. E2 and E3 used MNT2 to generate materials, which they then assembled in another environment. E1, E4 and E5, on the other hand, controlled the evolution of the materials entirely through MNT2. This distinction may explain the shorter duration of gestures stored in Gesture by E2 and E3 compared to the longer gestures created by E1 and E5 (Figure 12).

Both E1 and E5 stored complex paths in Gesture. While E1 used OSC messages to navigate the gestures, E5 simply played back the trajectories as they were recorded. E1's workflow involved generating a set of maps with Concatenate, then executing and recording trajectories based on sound results:

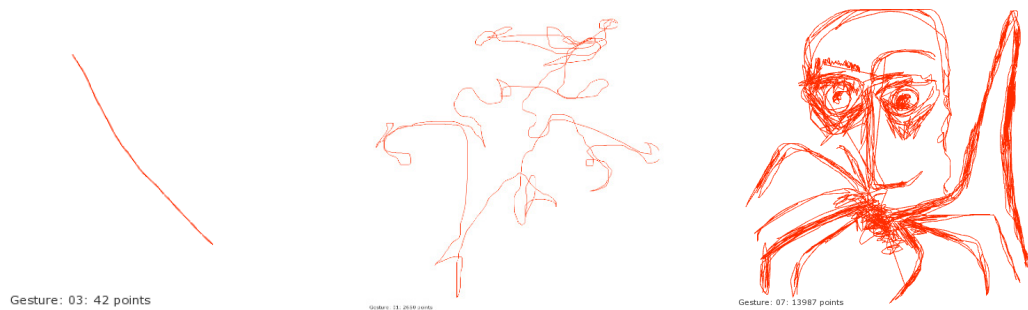
From the start, I was already thinking about the gesture: 'I'm going to start here and end there. I want it to begin rougher and transition into something more defined. I want to go through the lows, move away, and then come back.' While the map and the gesture are technically separate, conceptually they are very intertwined. In a way, the gesture was a consequence of how the material ended up being organized.

In contrast, E5 used Gesture to freely draw shapes without initially considering the maps they would control. They later designed an interpolated map and organized it to align with the stored trajectories:

In the last two sessions, I've been working with the module that allows drawing, which led me to spend a lot of time focusing on a single drawing. It was something that caught me by surprise—I didn't imagine I'd be doing that (...) I have a team I work with, and we try to approach artistic content generation from a transdisciplinary perspective. This got me thinking about how I could take some of these tools not just into performance but also into visual design. I'm working with Philip Glass's *Metamorphosis No. 1*, so I created a series of insect-inspired drawings to keep everything within a kind of ecosystem. It's quite fun to do and to listen to because the paths traced through the drawings also reflect the speeds of the strokes, which ends up generating shifts in the piece's sonic movement.

E4 did not use any instance of Gesture, relying instead on Noise to randomly generate trajectories.

Figure 11 - Use of Gesture



Source: Created by the author

Description of the image: Screen capture of Gesture configurations for E3 (left), E1 (center) and E5 (right).

4.3.4 User experience

After completing the composition task, evaluators participated in a semi-structured interview (Frame 3). With the exception of E1, all evaluators achieved a functional configuration in their first working session. This discrepancy may be attributed to E1's decision to develop a custom synthesizer in Pure Data specifically for the evaluation process. This task required harmonizing Concatenate's output with the input requirements of the `_grainer~` object. The other evaluators, however, largely adhered to the configuration models presented in the manual and tutorials, occasionally adapting them to their needs. They also frequently used devices included in MNT2, such as MNT::CONCATENATE, as well as technologies previously tested with MNT2, such as Ableton Live and the LoopMIDI virtual port.

All evaluators found MNT2 engaging and noted that it provided an effective medium for creative expression. E2, for instance, found in MNT2 a quick way to express complex ideas:

I found quick ways to do things that initially seemed very complex in a very short time (...) At first, I explored Concatenate and then Interpolate—those are the two I used the most. To start, I felt like I was able to easily create certain textures or things that would normally have taken me a lot of lines of code or the integration of multiple tools.

Regardless of whether they began the evaluation process with a pre-established plan, they often remarked that the map design and connection possibilities influenced their decisions, prompting them to explore new workflows. E1 commented that MNT2 shaped the way they designed their piece:

MNT2 sparked an idea and helped me bring it to life. I started with one goal, and along the way, another one emerged, which was a consequence of the software and interacting with its possibilities.

Similarly, all evaluators commented on MNT2’s user-friendly and intuitive interface. They found working with the maps allowed a playful approach. E3 found this to be one MNT2’s most prominent features:

It allows me to express myself. There’s a very rational stage at the beginning, but then it becomes quite visceral, and it lets you play around a bit. (...) It’s very playful. It didn’t take me long to get a result.

Finally, all evaluators expressed an interest in using MNT2 again and agreed that it could serve as a valuable tool for live control of synthesis parameters. E1, E2, and E5 found the application reliable. E3, however, suggested adding features such as an undo function and automatic backups to enhance reliability and safeguard their work.

Frame 3 - User experience

	E1	E2	E3	E4	E5
Time to first functional configuration	Multiple days	First work session	First work session	First work session	First work session
Found MNT2 interesting	Yes	Yes	Yes	Yes	Yes
MNT2 allowed them to express themselves	Yes	Yes	Yes	Yes	Yes

Found MNT2 to be intuitive	No	Yes	Yes	Yes	Yes
Found MNT2 comfortable	Yes	Yes	No	Yes	Yes
Found MNT2 challenging	Yes	No	No	No	Some tools
Felt in control	After an adaptation period	Yes	Yes	Yes	Yes
Found MNT2 reliable	Yes	Yes	No	No	Yes
Would use MNT2 live	Yes	Yes	Yes	Yes	Yes
Would use MNT2 again	Yes	Yes	Yes	Yes	Yes

Source: Created by the author.
Description of the image: Summary of answers related to user experience.

5. Conclusions

MNT2 was originally developed as a toolkit for designing interactive audiovisual environments. However, over time, it also demonstrated potential as a platform for sound design and studio-based composition. To further investigate these applications, a longitudinal evaluation was conducted in which five experienced musicians and sound artists integrated MNT2 into their creative workflows over several weeks. The study combined free exploration, structured compositional tasks, and semi-structured interviews, allowing observation of both technical configurations and subjective user experiences.

This article contributes to the field of digital musical instrument (DMI) evaluation in three main ways. First, it provides a longitudinal case study conducted outside laboratory settings, focusing on the integration of a mapping system into real creative practices. Second, it documents how a modular mapping environment can support heterogeneous workflows, ranging from granular synthesis in Pure Data to hardware-based sampling and DAW-centered workflows. Third, it offers qualitative evidence regarding how dimensionality-reduction

techniques and map-based parameter organization are appropriated by practitioners. These findings reinforce the importance of exploratory, practice-oriented approaches in the design and evaluation of mapping tools.

All evaluators successfully completed the proposed task, producing a piece. Notably, one of these pieces, *Territorio* by Damián Anache, was published in the compilation *Microtopies 2023: 79 miniatures de música i geografia*. Although some evaluators had access to sensors like those used in the projects that inspired MNT2's development, none chose to use them during the evaluation. Instead, they employed a wide range of input methods, including randomly generated data, envelopes controlled by other applications, MIDI controllers, general-purpose peripherals such as a mouse, and touch-based devices such as cell phones. The projects also demonstrated diversity in synthesis engines, including DAWs, Pure Data patches, and hardware synthesizers. This variety extended to the configuration of MNT2 sets, which featured different modules and innovative uses of the same module. For instance, the Gesture module was used to create short gestures lasting about 2 seconds, long gestures lasting approximately 1 minute, and intricate trajectories lasting up to 6 minutes. These examples highlight MNT2's flexibility and adaptability to different production styles and contexts.

All evaluators commented that MNT2 enabled them to express their creative ideas and found the application intuitive, at least in certain aspects. Most also described it as comfortable to use. Interestingly, several evaluators characterized their experience with MNT2 as "playful" and noted that they discovered their module configurations and map designs through iterative trial-and-error processes. The application's features often influenced and reshaped their initial work plans. Furthermore, the evaluators incorporated dimensional-reduction techniques and available audio and MIDI descriptors into their projects, even though these elements were not

deeply covered in the documentation. This exploration, too, emerged from trial-and-error workflows driven by the visual and auditory feedback provided by MNT2. These findings align with the objectives outlined at the start of MNT2's development: to create an environment that fosters the playful exploration of mapping strategies and promotes workflows where material representations shape potential solutions to creative challenges.

Overall, the evaluation suggests that MNT2 can function not only as a technical mapping tool but also as a compositional environment in which the spatial representation of parameters actively shapes creative processes. By encouraging exploratory interaction and the visual organization of control spaces, MNT2 supports workflows in which mapping is not merely a technical layer between gesture and sound, but a component of creative thinking.

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