Designing DMIs with(in) a Music Culture: A Participatory Design Process with the Xambá Quilombola Community

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ABSTRACT

This paper presents a participatory design process with the Xambá community to create new Digital Musical Instruments (DMIs) emphasizing the integration within their music culture. The project yielded two novel instruments, the *Agbaixo*, and *Botões Falantes*, engaging the community in every stage and considering the traditional instruments' entanglements in the materiality, corporeality, and sonorities of their music culture. This process was inspired by Paulo Freire's dialogical methods. It was conducted with community members of several ages and musical experience in a workshop over two months. The designed instruments were preliminary evaluated by community members in an informal context. The implications of this work, apart from creating instruments in conjunction with their final players, include an attempt to inspire a new bottom-up design process centered on existing communities situated in specific music cultures.

Author Keywords

DMI, Participatory Design, Paulo Freire, Xambá, Quilombola, Music Cultures

CCS Concepts

•Applied computing → Sound and music computing; Performing arts; •Human-centered computing → Participatory design;

1. INTRODUCTION

NIME Research has traditionally been carried out within specific socio-technical, cultural, and economic contexts, predominantly in Western [1] universities and companies, where access to financial and technological resources is often abundant. These instruments frequently emerge from a research process centered on technical implementation concerns rather than their situated musical outcomes within their cultural contexts [19, 15].

Engineering perspectives that prioritize technical features such as optimization, accuracy, or integration challenges of advanced sensors can lead to the creation of devices that, while technologically sophisticated, may not resonate with the practices and traditions of musical communities. Although we recognize the importance of such technical advancements, it is through its use in a social context that an instrument becomes musical [41]. These processes tend to happen on large time scales, through complex and unpredictable relations between the many agents that constitute a cultural context, but how can we consider these socio-cultural dimensions in the design process of new DMI?

This paper presents a participatory design process of two new DMIs conducted with the Xambá community, a Brazilian quilombola community with a music practice deeply intertwined with social life, political resistance, and religious practice [16, 2, 9]. A quilombola community is formed by mainly black Brazilian individuals who maintain a strong cultural and historical identity and collectively fight for their socio-cultural rights [11]. This participatory action research [10] was inspired by Paulo Freire's dialogical methods; based on a participant observation practice, we engaged with the community to analyze and codify elements of their music culture. This thematic analysis served as a starting point for the planning and facilitating a participatory process based on their materialities, sonorities, and corporealities as a strategy to cultivate new instruments in this rich music culture.

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[1]Although the concept of "West" has no single or simple meaning, we consider it a historical socio-political concept (not a geographical) based on Stuart Hall's definition which considered an inherent mythical and fantastical dimension to the concept, usually associated to a "type of society that is developed, industrialized, urbanized, capitalist, secular and modern", which has always included Western European countries, the USA, sometimes Japan and usually considers Latin America to be "struggling not very successfully to catch up" [17]

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2. THE SOCIO-CULTURAL DYNAMICS OF DMIS

The discussions around the socio-cultural role of technology in digital musical practices have been gaining momentum in recent years [37]. New organological frameworks encourage us to acknowledge the multifaceted nature of instruments, considering not only the sounds they produce (sonorities) but also acknowledging their cultural dimension, their gestural repertoire (corporealities), and material culture, amongst other aspects [27]. Ecosystemic perspectives have suggested "a musical instrument is not an object but a process" [41], shifting our perspective from objective notions of *instruments* towards a relational *instrumentality*, a quality dynamically negotiated within cultural contexts [18].

Ignoring the socio-cultural dimension in a design process may cause us to miss an essential aspect: it is the process of playing an instrument in a situated cultural context that makes it a musical instrument. Certain fundamental concepts tied to the practice of music with new instruments, such as *skill*, were identified to be dependent on an existing community of practice [28, 14].

Recent papers at the NIME conference have highlighted the need for critical discourse incorporating socio-political dimensions of music technology [19, 31, 4, 39]. Establishing the NIME Latam Network [29] offered a concrete understanding of the challenges and potential of creating an inclusive international network amidst diverse cultural contexts. However, despite the growth of NIME research from non-Western perspectives [3, 40, 29, 20, 35, 24, 32, 23], an existing Eurocentric bias still perpetuates limiting dominant narratives [19].

Escobar's Pluriversal Design theory, grounded on the concept of ontological design [42], celebrates the notion of a *pluriverse*. This *pluriverse* advocates for the co-existence of diverse worlds, contesting Western norms of universal knowledge [12]. While Escobar acknowledges musicians as key in keeping the *pluriverse* alive, we argue that the creators of new instruments, including luthiers and inventors, also play a meaningful role in this endeavor.

Digital technologies have accelerated the pace of globalization, intensifying its effects of homogenizing and erasing traditional practices of marginalized communities. We understand the transformative potential of this work to subvert the role these technologies play against the hegemonic top-down approach, from "the West" to "the rest"[17]. Through this *participatory action research* [10] in a racialized community[2], we advocate for a bottom-up decolonial resistance by designing digital technology for music as a quilombola effort to keep the *pluriverse* alive.

3. XAMBÁ COMMUNITY CONTEXT

The Xambá community is a Brazilian quilombola community located in the Urban Quilombo[3] Portão do Gelo on the outskirts of Olinda, Pernambuco, in the northeast region of Brazil. They were officially granted the title of an Urban Quilombo for their collective actions to preserve their history and identity through the Terreiro de Candomblé Nação Xambá[4], their main religious ceremonial space [25]; for creating the *Memorial Severina Paraíso da Silva (Mãe Biu)* (a museum inside the terreiro [33]); for building the *Centro Cultural Grupo Bongar: Guitinho da Xambá*, their cultural center; for holding each year the *Coco de Mãe Biu* party[5], where they maintain the *Coco da Xambá*[6] tradition alive; and for the actions of the music group *Bongar*[21].

Grupo Bongar[7] has played an important role in these efforts, having strategically worked to valorize and disseminate the community's culture through music [2, 1]. Being one of the most prestigious Coco groups in the World, they play the Coco da Xambá genre and compositions based on their religious music [9]. They respectfully innovate their traditions by blending profane and religious elements and experimenting with other styles and instruments from outside, such as the piano, cavaquinho, guitars, and bass. They recently have included a DMI: the Roland SPD-S sampler pad.

The community's interest in engaging with new musical technologies opened the possibility for dialogue in this participatory design process. The decision of one of the Bongar's members (Thúlio Cláudio de Albuquerque Nascimento, Thúlio Xambá) to use an SPD-S was motivated by the practicality of transporting fewer heavy instruments and exploring new sound possibilities. They use the instrument to play sounds that traditional instruments cannot, like a sub-bass sample from an 808 kick drum, some congas with specific effects, and some recorded voice audio samples.

There are other issues related to this instrument, such as it being too expensive for the community's economic reality. Another group member (João Alberto Santos Silva, Beto Xambá) bought the same instrument but did not integrate it into his instruments set, feeling it didn't work as a familiar percussion instrument. Even though this instrument represents an opening of the community to the DMI world, we believe a process to create new digital instruments based on their context has many interesting opportunities to be more affordable and better integrated into their music practice well beyond their expectations with DMIs.

4. METHODOLOGY

A relationship of friendship came before starting this research. We had collaborated with Thulio before on a musical performance with custom-made DMIs. Based on the admiration for the Xambá community music, this project was proposed to go beyond individual collaborations to a collective approach with the community. Seeking a methodological approach that would help us center the process around their cultural context in a respectful and profound way, we conducted a participatory design process inspired by Paulo Freire's educational philosophy, his concept of dialogics, and the methodology of thematic investigation [13]. During the process, we did not try to have a distanced perspective; on the contrary, we tried to have a horizontal dialog with the

[2]We understand race as a process of oppression, based on Anibal Quijano's category "Coloniality of Power" [34], which "operates from the racialization of relations across social and geocultural identities" [36].

[3]Quilombo is the name of the geographical territory that integrates the quilombola community.

[4]Candomblé is an Afro-Brazilian religion of oral tradition based on worshiping their deities, called *Orixás*. A vídeo of a ceremony to the *Orixá Oxum* at the Terreiro de Candomblé Nação Xambá by Vincent Moon & Priscilla Telmon (Petites Planètes): https://youtu.be/kfVKfBDtkH0

[5]Vídeo 57th edition of the Coco de Mãe Biu party by Terreiro de Candomblé Nação Xambá: https://youtu.be/CQ-YF1Xc6UA

[6]*Coco* is a cultural manifestation of mainly music, dance and poetry from northeastern Brazil, and *Coco da Xambá* is a specific branch Coco from the Xambá community.

[7]Teaser of the *Grupo Bongar* DVD *Festa de Terreiro* performing the song *Ogum* with other members of the Xambá Community: https://youtu.be/TMXhQU84UH4

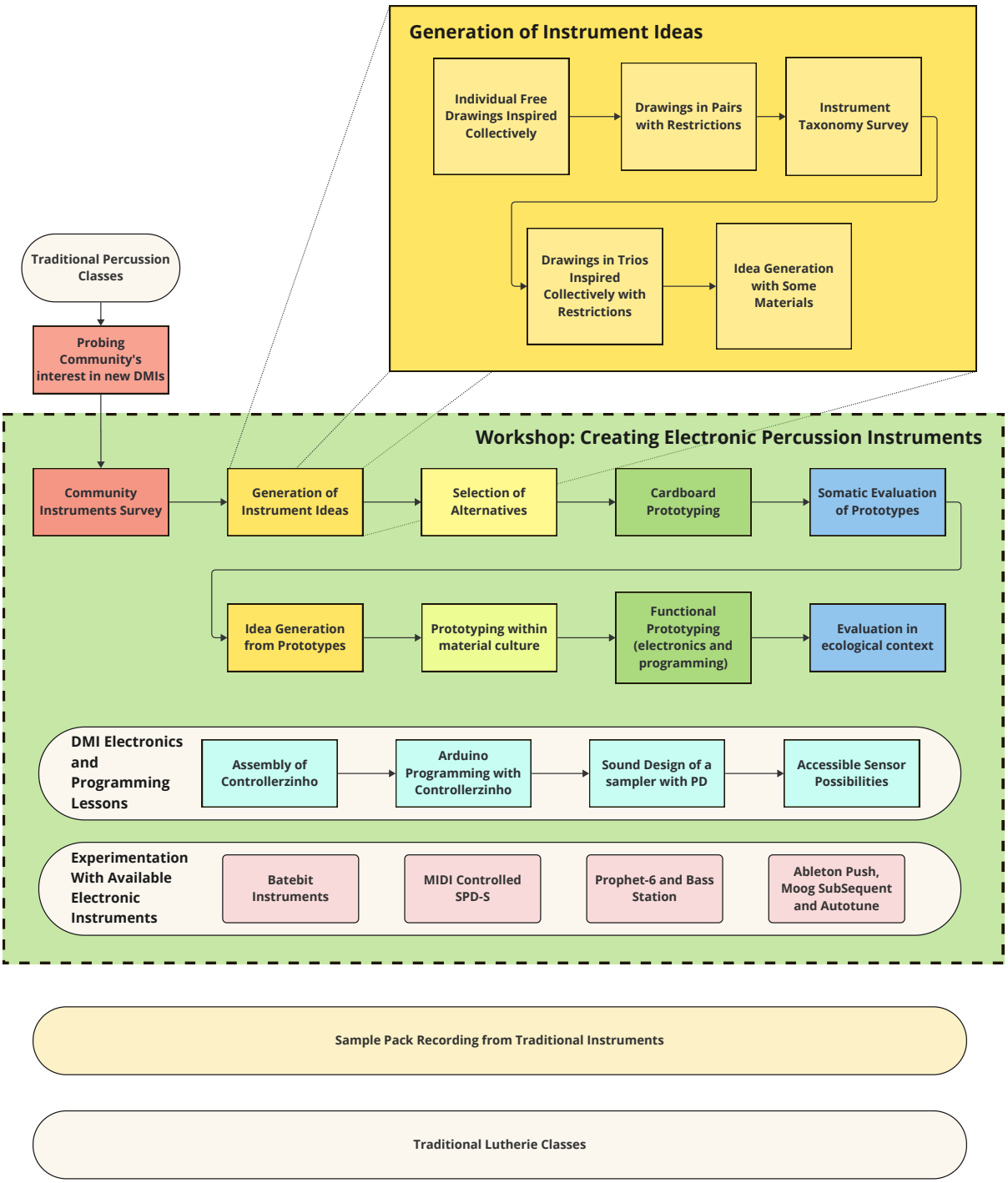

Figure 1: Diagram representing the structure of the research. The green area represents the activities of the workshop *Creating Electronic Percussion Instruments*. The yellow rectangle is part of the workshop and represents the different idea-generation sessions. The other elements represent other activities that were conducted before (above the green rectangle) and in parallel (below the green rectangle) to the workshop.

community based on mutual trust. During the process, we positioned ourselves as participant observers, suggesting as much as listening to the participant's suggestions.

Four months before starting the Design Process, the first author (Tragtenberg) started a Participant Observation practice through percussion lessons with Thúlio Xambá, traditional instrument-making lessons with Iranildo Gomes da Silva (Iran Silva), and attending public community events such as the Coco da Xambá. Thúlio played a pivotal role in the planning phase, sharing his knowledge about the community's music practice and inviting all the participants to the workshop.

The demand for this design process did not come from the community but from the researchers. To evaluate if this proposition was interesting for the community, we hosted an event at the cultural center to experiment with DMIs we had previously developed.

They played with Giromin [3, 38], Probatio [7], and Controllerzinho [6], along with their traditional instruments. Thirteen people attended this informal event, and within just a few minutes of testing the instruments, they were already jamming and having a great time. This enthusiasm demonstrated a potential interest in participating in the design process.

We organized the process in the format of a workshop called *Creating Electronic Percussion Instruments*, which lasted 2 months, having two sessions per week. This workshop was organized by two main facilitators: Tragtenberg and Thúlio Xambá; Two assistants from the community: Anderson Luiz Paraizo Pinto (Ninho Brown) and Paulo Henrique Lourenço da Silva (Henrique Bongar); A somatic educator: Orun Santana; Two sound designers: Miguel Mendes and Tomás Brandão Correia (TomBC); and the executive producer: Laura Proto. During the process, 29 participants from the community attended (11 women and 18 men, all of them black, of which 9 were below 13 years old and one person with physical disabilities). 12 participants attended only one day, and the number of attendees each day fluctuated significantly, ranging from 2 to 14 people. All 6 *Bongar* musicians attended at least one day of the workshop.

Figure 2: Tarta de Melo and Thúlio Xambá soldering instrument prototypes at the community's cultural center, *Centro Cultural Grupo Bongar: Guitinho da Xambá* during the Workshop *Creating Electronic Percussion Instruments*.

The workshop participants were invited personally by Thulio Xambá, who was active in one or more of the collective activities of the Quilombo. From the participants who attended more than 2 days of the workshop (59% of all participants):

- 100% contribute to the activities of the cultural center;
- 94% of play at least one of the instruments in Table 1, most of them having learned in religious or community contexts, with few having had formal music training;
- 88% live within a 1km radius of the cultural center;
- 76% participate in the Terreiro de Candomblé Nação Xambá;
- 3 participants had personal laptops, and 2 could bring them to the workshops;
- Only 1 participant (Tarta de Melo) had experience with DIY electronics, having built a driving game controller with an Arduino;

The workshop process began by conducting a survey of the most important instruments for the community. We did this by asking the participants to draw the three they most liked/wanted to play and then selecting all that were voted on by at least 2 people. We also included instruments that were part of the instrumentation of *Coco da Xambá* and *Grupo Bongar*, which were the most relevant musical practices for the workshop participants. This list is presented in Table 1

Table 1: Most Relevant Instruments for the Community from Survey (numbers represent the number of votes each instrument had)

Peles (Low-Pitched)	Shakers	High-Pitched
Alfaia (8)	Ganzá (6)	Agogô/Gan (6)
Engome (5)	Agbê (6)	Berimbau (4)
Pandeiro (5)	Pandeiro (5)[8]	Piano (3)
Congas	Maracas (1)	Mbira (2)
		Bottles (2)
		Matraca
		Snare Drum

4.1 Thematic Investigation

From the thematic investigation we carried out, we raised three transversal generative themes to approach the design process: materialities, corporealities, and sonorities[9]. The design techniques we applied were chosen to approach these three themes.

4.1.1 Materialities

From the participatory observation of the traditional instrument-making classes with Iran Silva, we analyzed which materials were used and which tools to make what shapes and forms. The process was focused on making an Alfaia, the instrument most people voted for in the workshop's initial survey. We also increased our understanding of their musical material culture through the drawings people made during the process to generate ideas for new DMI. Some elements that emerged from these were many cylinders, rims, pads, *cabaças* (gourds), and *buzios* (conch shells).

All these materials were made available at the last idea generation stage and the "Prototyping within material culture" part of the Design process (Figure 1).

[9]All generative themes were considered in the plural, understanding these aspects within this community are not homogenous, but diverse and dynamic.

4.1.2 Sonorities

We organized musical experimentation sessions with our available electronic instruments throughout the process. Since most people who attended the workshop had never played any DMI before, these moments of free exploration would give them some reference to what is concretely possible with digital technology. We presented some DMIs developed by the first two authors (Giromin [3, 38], Pandivá [3], Controllerzinho/Batebit Controller [6], and Probatio [7]) as well as commercial gear the sound designers of our team had: TomBC's Ableton Push 2 [10], Moog SubSequent 25 [11] and Antares Auto-Tune Artist [12] processing voice; Miguel Mendes' Sequential's Prophet 08' Desktop [13] and Novation Bass Station II [14]; Thúlio Xambá's Roland SPD-S [15] and Beto Xambá's Roland SPD-SX sampling pad [16]. Although these instruments did not have a specific relationship with the community's music culture and were very expensive, we decided to use them for experimentation since they were the only DMIs we had available on the team to broaden their knowledge of what are design possibilities with electronic technologies.

Another important step was to *digitize* the community's instruments by recording a sample pack. We noted from the observation how they considered it important for the digital instruments to sound "organic". Miguel Mendes structured the studio process, where they recorded each one-shot sound three times for each three different velocity levels, to capture their natural variations; Loops of traditional rhythms and one-shots. Miguel used Ableton Live to program samplers to be played with MIDI Controllers, using an LFO to change between each sample and a velocity mapping to give the sampler instruments a more "organic" feeling.

4.1.3 Corporealities

Inspired by the Soma Design Framework [22, 30], we implemented a process of Somatic Education before every idea generation process to include the body in the creative design practice. The facilitator was Orun Santana, a contemporary dancer and musician of Afro-Brazilian references.

Participants greatly appreciated these activities, which helped bring many insights regarding the other generative themes of sonorities and materialities. One activity he facilitated involved the improvisation of mappings between free gestures and sounds. He helped us understand how people's mappings were related to percussive gestures triggering percussive sounds. From that observation, we noticed how sampling could be an interesting sound production strategy for the instruments.

After each prototyping session, we also used a somatic technique to evaluate the instrument by improvising gestures and vocalizing sounds. Many interesting ideas came from this technique.

4.1.4 DMI Design Technical Classes

As well as basing the process on a bottom-up approach through the three generative themes, we also followed a top-down initiative, giving introductory lessons on techniques of DMI Design (mechanical structure, Arduino programming, sound design with Pure Data, and sensor technology) through the Controllerzinho teaching toolkit [6]. These were aimed at providing a technical dimension of the possibilities for the participants.

Many difficulties arose from these lessons: only two participants had computers (which were very slow), the available projector from the cultural center had low visibility, and people had difficulty learning to program because of the language barrier of the C language (no one could understand English), and they had little familiarity with using a keyboard and mouse since their access to the digital world was mainly through mobile phones.

After accepting these limitations, we focused these lessons on showcasing sensor possibilities rather than making them program. We selected some accessible sensors with low cost and for fast prototyping that could resonate, from our perspective, with the community's corporealities and materialities:

- Buttons
- Piezos (pads and silent drum heads with triggers)
- Capacitive touch sensors
- Reflective IR distance sensors (TCRT5000)
- IMUs (Inertial Measurement Units)
- LDRs (Light Dependent Resistors)
- Potentiometers

These sensors played a crucial role in the ideas generated and in their prototyping. We limited the ideas to those that could be implemented with these sensors so that they would be fast, inexpensive, and easy to prototype later.

4.2 Idea Generation Process

All the idea generation techniques were inspired by the concept of *instrumental inheritance*. Calegario proposed a method based on this concept, where it should be used to "explore and generate ideas based on common knowledge and existing cultural hooks, serving as an initial, structured, and exploratory path for idea generation". Instead of augmenting or emulating existing instruments, this method suggests existing instruments as inspirations for designing new DMIs [5]. We also adapted the Brain-Writing (6-3-5) method [26] to the context of each idea generation session.

The facilitation of this process was incrementally enhanced by introducing restrictions at each step, which were designed to consider specific instruments as creative guides. These guides aimed to stimulate the integration of new DMI ideas into the traditional repertoire of instruments. Given that these instruments were coherently related, being part of the same music culture, we combined them in various ways.

Instead of writing ideas, we preferred to ask them to draw and prototype with materials so we could also learn about their material culture's imaginary [17] throughout the process.

4.2.1 Individual Free Drawings Inspired Collectively

In this technique, 7 participants were seated in a circle, each with five minutes to generate an idea for a digital instrument on a sheet divided into eight sections. Following this, the

[10] https://www.ableton.com/en/help/learn-push-2/
[11] https://www.moogmusic.com/products/subsequent-25
[12] https://www.antarestech.com/products/auto-tune/artist
[13] https://sequential.com/product/prophet-08-module/
[14] https://novationmusic.com/products/bass-station-ii
[15] https://www.roland.com/us/products/spd-s/
[16] https://www.roland.com/us/products/spd-sx/

[17] "ways in which people collectively and pre-theoretically make sense of their social and personal existence, to constitute a collective space of meanings or semantic space for co-being" [43].

sheet was passed to the adjacent participant, who had five minutes to develop a new idea inspired by the one already on the paper. This process was repeated until a total of 49 instrument ideas were generated.

4.2.2 *Drawings in Pairs with Restrictions*

On a different occasion, the group of 4 participants was divided into pairs. Each pair chose 2 or 3 instruments from the community's instrument list to inspire a digital instrument design within 30 minutes. Subsequently, they were asked to repeat the process on another large sheet of paper, resulting in the conception of four instrument ideas, including the *Agbaixo* instrument (Figure 3).

4.2.3 *Instrument Taxonomy Survey*

During this activity, 8 participants categorized the community's instruments, identifying a taxonomy consisting of: skin-based instruments (low-pitched), shakers, and high-pitched instruments of Table 1. It is interesting to point out that the piano was included in the category of high-pitched instruments. This highlights how the concept of notes is not so relevant to this community, which probably tends to consider all percussive sounds from the timbral perspective. Although the piano has a big extension from low to high pitch, its function in their music probably plays a role closer to the other high-pitched instruments on the table. This taxonomy reveals a very interesting aspect of this community, which would radically diverge from a Western classical music perspective.

4.2.4 *Drawings in Trios Inspired Collectively with Restrictions*

8 participants were organized into three groups to draw on large sheets divided into three parts, with ideas restricted to the category and the condition that the instruments would be playable on the street, an aspect in which most instruments in Table 1 follow. Each group had 30 minutes per drawing before passing the sheet to the next group. Each sheet represented an instrument category, serving as inspiration based on that category and the ideas generated earlier in the process. In total, nine instrument ideas were proposed through this activity, including the initial draft of the *Botões Falantes* instrument (Figure 4).

5. RESULTS

From the 62 instrument ideas conceived, concerns arose about selecting a specific instrument for further prototyping. However, only two participants attended on the day designated for creating cardboard prototypes with selected ideas. Curiously, each one was fixated on an instrument idea that had captivated their imagination, which became the starting point for the *Agbaixo* and *Botões Falantes* instruments. We respected this spontaneous response from them instead of forcing them to do the previously planned design activity.

5.1 Agbaixo

The *Agbaixo* [18] instrument emerged from the *Drawings in Pairs with Restrictions* technique inspired by the Agbê and Berimbau, incorporating a cut-in-half cabaça (gourd)

[18]Video of a Demo of *Agbaixo* by Miguel Mendes: https://youtu.be/UNRNkNTN5Kc

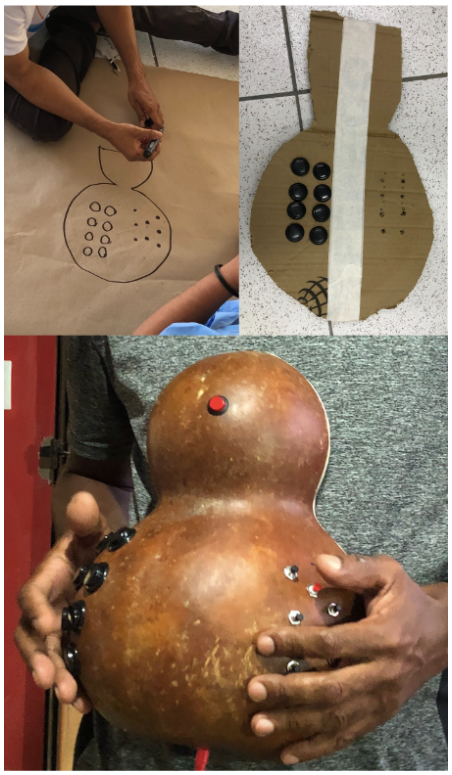

Figure 3: Pictures of the *Agbaixo*'s design process and final version. From top to bottom, left to right: the initial drawing; the cardboard prototype; current version

from an Agbê with functionalities reminiscent of the eight-bass (known locally as *oito baixos*) accordion, a widespread instrument in Brazil's Northeast. Its name was given by Ninho Brown, derived from combining the names of the Agbê and *oito baixos*.

It features eight large buttons for triggering percussion samples with the right hand (probably inspired by the Controllerzinho buttons) and eight smaller ones for playing bass notes with the left. The cardboard prototype did not change much since it remained bidimensional due to the difficulty of shaping the cabaça (gourd) with that material.

The final prototype was made by cutting a large gourd in half and attaching the buttons, considering what was learned from the materialization generative theme. During the process, we would sometimes meet in other informal contexts, and while Ninho Brown was fixated on that instrument idea, he mentioned an insight about implementing Ableton Push's "repeat" function into *Agbaixo*, where the small buttons would select the repeat pattern and the bit buttons would select the sample to be repeated.

The electronic circuitry was built with an Arduino Pro Micro on a protoboard, which we programmed and designed the protoboard schematics based on the collectively chosen features, and the participants from the community assembled and soldered. Due to limited time and resources, the instrument was programmed as a MIDI controller to play the sound-designed Ableton Live sample instruments instead of embedding the DSP for sound generation.

The definition of which samples to be used was conducted by Miguel Mendes and the participants from the community. Based on its initial conception of the buttons on the left hand playing bass sounds and the right hand playing percussion sounds. Miguel would show many possibilities of bass samples he had available on his computer, ranging from acoustic

basses to synth-basses sounds. The participants chose a Prophet 08' Desktop sample-pack Miguel had recorded previously from his synthesizer. Considering most of the community had little experience playing melodic or harmonic instruments, Miguel opted for arranging the buttons on a pentatonic scale, seeking to minimize dissonances between notes.

From a "non-Latin" perspective, using a Prophet synthesizer bass sound may seem artificial for a Latin American community with no tradition of playing synthesizers. We understand traditions as a dynamic set of agreements, which evolve in time depending on individual and collective decisions from within each community. We took the traditional instruments as inspirations for the new ones but also brought many references from existing commercial and DIY gear. Latin American cultures have had a tradition of hybridization we acknowledged and accepted as an important part of the design process [8]. The participants from the Xambá community had an open mind for experimenting with new possibilities, having shared or individual tastes for what sounded interesting or not. We respected their choices and stimulated them in a search for interesting new possibilities without trying to force them into a rigid perspective of what their culture is.

For the percussion samples, Miguel chose with the participants the samples of the instruments previously recorded by themselves. The eight buttons would trigger samples from the Alfaia, Ganzá, and Snare Drum sample instruments. These were triggered through the MIDI protocol in Ableton Live using the "Drum Rack" module. Each MIDI note triggered a different Sampler module with 3 different selection "zones", each with a recorded variation of the same gesture on the acoustic instrument. A low-frequency oscillator (LFO) at 1Hz would select a different sample, emulating the natural variations a percussion instrument has across many repetitions of the same intended gesture.

To implement the "repeat" function, we added another red button to its front so the tempo could be sensed using a "tap tempo" control. This mode would immediately make the LED from this button blink on tempo. The repeat mode would be turned on by this action or could be turned off back into the original trigger mode by holding the red button for 3 seconds. This mode would disable the bass samplers from the left-hand buttons, changing their function to select the repetition pattern (with 1, 2, 3, 4, 6, 8, 9, 16 even divisions of the tapped tempo) of the last button selected on the right hand. The first author programmed these time divisions in the microcontroller firmware based on what was collectively decided; since the time divisions weren't decided, he made these choices and validated them with the community, which agreed with these decisions.

5.2 Botões Falantes

Botões Falantes [19] consists of a structure with 3 trigger buttons that could shift their pitch if the lateral structure is bent, similar to a talking drum. It means "Talking Buttons" in Portuguese, and this name was proposed by the first author and agreed with the participants. This instrument emerged from the "Drawings in Trios Inspired Collectively with Restrictions" idea generation process. It was the first drawing from a group for a digital low-pitched instrument inspired by the "low-pitch" category (Table 1. The trio had no ideas in the first 28 minutes of the activity, with many discussions going nowhere. As a simple solution, playing with the physical detachment between the gestural interface and sound production, they suggested a small cylindrical pot with 2 buttons to play very low-pitched sounds.

[19]Demo of Botões Falantes by Miguel Mendes: https://youtu.be/oIFhlwC83dc

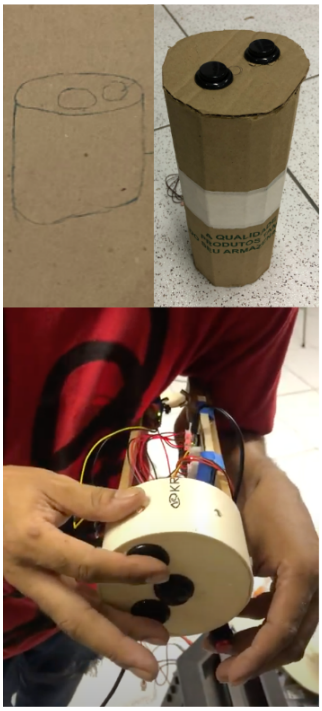

Figure 4: Pictures from the *Botões Falantes* design process and final version. From top to bottom, left to right: initial drawing; cardboard prototype; current version

One of the members of this group, Joheliton Miranda Albuquerque (Joheliton Miranda), was very excited about this instrument and frequently mentioned how amazing the simple idea of this instrument was. He is a percussionist from the Maracatu Estrela Brilhante, a tradition that usually performs during carnival, and plays a very heavy Alfaia while walking for kilometers with his group. He had polio in his childhood and has a physical disability on a leg that demands the use of appropriate orthosis. When asked if he had difficulty walking with such a heavy drum, he said it was no effort. Even so, it is interesting that this instrument is an accessible solution for people with motor disabilities to play in Carnival parades.

For creating the cardboard prototype, Joheliton used a cardboard cylinder a little longer than he had drawn and was available at the workshop. While testing it on his body, he liked the affordance of it being holdable near an armpit, freeing both hands to play. Ninho Brown immediately mentioned it resembled a talking drum, an African percussion instrument. The first author suggested implementing the feature to pitch shift the samples. The group liked the idea and spent some days thinking about the possibilities of adding this frequency shift control feature. While Joheliton was considering using a rotary potentiometer, Tragtenberg investigated the possibility of using reflective IR distance sensors.

Considering possible flexible structures allowing the distance sensor to detect how much the instrument was bent on the sides, Diego Gomes Melo (Tarta de Melo) proposed using a 100mm PVC sewage pipe, which is 2mm thin in Brazil. It is interestingly flexible if cut in a low-height ring. He suggested this material as a sustainable solution since it is easy to find the remains of this pipe on construction sights. It is relevant to point out that Tarta works mainly as an electrician and a generalist construction worker. By

using available plywood and some wood slats, we built the structure using wing nuts and screws. This structure allowed the reflective IR distance sensor to measure the distance between the two opposing wood slats.

We later added a 3rd button to trigger samples and another red button to change between three sample pages, allowing it to play nine instead of three different sounds. To add sensitivity to how strong the buttons were struck, we also added two 17mm ceramic piezoelectric discs near the buttons to add velocity sensitivity. The first author implemented the firmware based on the collectively defined features. As one of the three buttons was pressed, the intensity was measured by detecting the maximum value in a 10ms time window after the button was pressed. This would compose a MIDI Note On message with a mapped value for the velocity followed by a Note Off message. The reflective distance sensor reading would be mapped to a pitch bend message.

We used Ableton Live's drum rack module, triggering a "Sampler" module like in the *Agbaixo* configuration. Since this instrument gave different velocity values, we used 9 recorded samples for each Simpler module, which would be mapped in zones depending on the MIDI velocity, having 3 variations for low, medium, and high intensities gestures, which would be selected by a 1Hz LFO. Each sample page was related to one traditional instrument: Alfaia, Engome Melê (higher pitch), and Engome Ian (lower pitch). Each of the three trigger buttons would be mapped to three different recordings of gestures (for example, the mallet hitting the rim, the drum head, and multiple fast strikes on the drum head).

Although most of the electronic instruments they played were restricted to being played on top of a table, both instruments they invented were designed to be portable like their traditional instruments. The demand for a self-contained instrument, which had embedded DSP, was a clear demand that we couldn't implement during the available time of the workshop. Although it was acceptable for them to have an instrument that could not be moved while playing (like the Engomes, Congas, and Alfaias or Snare Drums when fixed on stands), the need for a computer was accepted as a work-in-progress but had a clear demand for a new version with an embedded sampler.

5.3 Preliminary Evaluation

The evaluation of the 2 instruments was conducted in an informal community setting, integrating both cultural context and technical aspects. Delays in development, especially with embedded DSP and inadequate computing capabilities for running Ableton Live in computers from the participants, meant relying on equipment from people external to the community, which restricted the available time and depth of testing and community learning.

Initial practical tests were held in Recife's city center during pre-Carnival events, where community musicians used the new instruments alongside traditional instruments. Feedback from the participants highlighted the instruments' potential for deeper musical integration, with Beto Xambá expressing enriched musical possibilities far surpassing those offered by commercial DMI: "I have already found things to play, to use, [with *Agbaixo*]. My head is already boiling with possibilities. I think it generates in me a desire to include it [in my set of instruments], even much more so than the SPD-S, although it has much more possibilities, you did something that generates in me a much greater desire to integrate into life."[20].

[20]Translated by the authors from Portuguese.

There were also some divergent remarks for *Agbaixo*; while Joheliton Miranda suggested adding a lever to allow changing octaves to play more notes, Thúlio Xambá suggested changing the sound design not to play notes, but only percussion sounds on both hands since it would take a longer time for them to learn how to play a melodic instrument than a percussion instrument. Nevertheless, these initial impressions would need more time to be thoroughly evaluated.

These evaluations are first impressions of initial prototypes, promising but requiring further refinement and extended testing to realize their full potential. The community's proactive role in the continued development, highlighted by their initiative to establish the *BongarBit* Lab for ongoing DMI design, underscores the project's collaborative nature and the community's strong identification and ownership of the initiative.

6. DISCUSSION

The technical limitation of depending on computers was the most important limitation of the current prototype. This dependence on the design team from outside the community to play the instruments shows a serious limitation of the project so far. It urgently calls for a new version with an embedded sampler solution. We understand this limitation as a step of the research we plan to overcome soon. We have traced some goals for building incremental autonomy of the community over their instruments:

- The next step is to allow them to be played by the community members without the need for people or equipment from outside;
- After that, to have autonomy to reproduce these instruments with accessible materials;
- Lastly, For them to have autonomy over the creative process of new instruments designed by themselves.

Another point we would like to address is the affordance of playing in walking bands in contexts of Carnival or other street parades, which would demand the design or use of a portable speaker system as well as the embedded DSP. We believe the design process and instruments presented in this paper are the beginning of the work of Bongarbit Lab, which has big and exciting challenges ahead.

7. CONCLUSION

This paper presented an intention to diversify the cultural context in which DMI design occurs. By moving beyond the traditional Western, academic, and predominantly white spaces where NIME research is typically conducted, the study embraces and explores the rich potential of engaging the Xambá quilombola community. This approach challenges conventional methods of musical instrument design, which often lean heavily towards being technologically intensive, but also enriches the field with fresh perspectives tailored to meet specific cultural and social needs.

By focusing on a "bottom-up" strategy, the project aligns technology development with the cultural contexts of the participants. It is an example of how dialogical processes based on Paulo Freire's methodology of Thematic Investigation can center a design process on the entanglement of new DMI into existing music cultures.

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We would like to dedicate this paper in memory of Guitinho da Xambá, founder, composer and singer of Grupo Bongar, a dear friend, and an inspiring activist from the Xambá Community.

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9. ETHICAL STANDARDS

This research ensured that all individuals mentioned provided their authorization for being nominally cited in this paper and confirmed their informed consent to participate in the participatory design process. All workshop producers and participants were financially compensated for their work. Agreements were made to allocate a significant percentage of profits to the cultural center in case the DMIs *Agbaixo* and *Botões Falantes* are to be commercialized. Additionally, all participating minors had explicit parental consent, ensuring ethical compliance throughout the project.

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