

SONOLOGIA

2019 | I/O

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Methodological considerations of practice-based-research in the field of sonology: the NuSom interactive practices group

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Abstract. This paper reflects on the processes of the NuSom Interactive Practices Group bringing them to the discussion about methodological research models and the production of knowledge in the field of Sonology. Firstly, it presents a conceptual basis discussing the theoretical work of thinkers who deal with research based on practice, since this concept has been increasingly adopted in recent years in processes integrating scientific research and creation. We will analyse how this practice-based research differs from the conventional modes of academic production and to what extent it can contribute in the construction of useful evaluation criteria able to rank the artistic works and practices carried out in the academy. The text then focuses on the activities of the NuSom Interactive Practices Group, (GPI, 2018) grounded in the ECA/USP and comprised by members of the Sonology Research Center. The purpose is to observe critically our own research practice experiences, drawing attention to the methodological and procedural aspects experienced by the group, encompassing questions of composition, musical performance, sound art, electronic prototyping and musical computing.

Keywords: Creative Practices, Methodology, Practice-based Research, Experimental Lute, Hacking.

1. INTRODUCTION

By referring to practice, we do not only understand it as a complementary opposition to traditional theoretical processes, but rather as an autonomous mode of knowledge production addressing a set of gravitating concepts. Thus, the first section of the text will discuss some of the concepts supporting both, the logics and logistics of the Practice-Based Research

(PBP), such as experimentalism and heuristic, nonlinearity, uncertainty and ambivalence of predetermined objectives and the unfinished condition of results and products. The discussion confronts authors from different disciplines who approach these concepts with proposals in the field of music, design, art-science and interdisciplinary and collaborative art.

Our discussion continues by considering PBP concerns that are particular to the space and time where the academic activities are being developed: the Public University of Latin America - in our case, the School of Communications and Arts of the University of São Paulo (ECA-USP). In contrast to the current hegemonic view, disseminated by European and North American institutions - such as IRCAM, SARC and CCRMA - and explored by collectives of researchers who meet annually at internationally recognized conferences such as ICMC or NIME, this text develops ideas about PBP from an economically peripheral positioning.

By attending to the circumstances and necessities of our sociocultural context, we seek to reorganize the agenda of priorities of the hegemonic discourse, presenting possible directions in a unified field of Sonology.

In doing so, we will debate about the role of collaborative creation, interaction, musical communities, experimental processes, open hardware and software as strategies to deal with technological asymmetry, gambiarra practices, hacking and technological disobedience as tactics to tackle the unavailability of technological resources, tools and instrumentation.

A broad spectrum of concepts fueled the group's discussions such as audio portability and mobility, ubiquitous computing, sonification, internet of things and wearable technology. Thus, we will see how the convergence around these ideas has brought us closer to a set of technological tools of software and hardware (Arduino, Raspberry Pi, Pure Data, ESP8266) facilitating individual and collective processes of electronic prototyping.

The last section is devoted to a critical reflection on the results obtained in a year of meetings of the Interactive Practices Group (GPI-NuSom), emphasizing both the process of creating the projects developed and the organization of the exhibition "Sons de Silício" - to be held in April 2019 at the Space of the Arts of USP - representing an important milestone in our research process. The evaluation of the methods adopted and results obtained throughout this process offers a sketch of contribution to the global, local and regional discussion that advances between the music and the recent technological innovations, addressing not only technical questions but also some of its sociocultural dimensions.

2. THE DEBATE ABOUT RESEARCH IN THE ARTS

In this section, we will outline theories about the research in Arts by reviewing the work of authors coming from related areas. These discussions are fundamental because they support the next section, where we will verify how our practical work can be linked with such ideas about research. Thus, our first discussion will address pertinent topics such as: action research (Frayling, 1993), performative research (Haseman, 2006), musical experimentation (Mauceri, 1997); musical communities (Shelemay, 2011), collective creative processes (Salles, 2017) and art-science (Born & Barry, 2010).

2.1. Action Research

From a historical perspective, it is worth mentioning the early reflections on research methods related to artistic work coming from the area of Design. The seminal article “Research in Art and Design” written in 1993 by the British researcher Christopher Frayling has served as the grounds for discussing the adoption of scientific mechanisms in the development and evaluation of master’s and doctoral studies in the Arts. Along with Frayling, other commentators of his categories of analysis such as Borgdoff (2004) and Findeli (2008), comprise an essential literature on the subject.

Frayling seeks to overcome the misunderstanding about the terms artistic and scientific research. The former is discussed by analysing an interview with Pablo Picasso, where research is defined as “the gathering of reference materials”. The author states that research, with lower case letter “r” search would be “... where the thinking is, so to speak, embodied in the artefact, where the goal is not primarily communicable knowledge in the sense of verbal communication, but in the sense of visual or forward, but still identifiable and visible iconic or imagistic communication.” (Fryling, 1993: 5).

The latter, corresponding to scientific Research, where capital “R” is used, the objective is the production and validation of new knowledge through a type of work directed towards the innovation, introduction, and improvement of products and processes. In this sense, the text of Frayling is an early effort in delimiting the boundaries of scientific work in Arts and Design, beyond the “hard” sciences and the humanities.

By appealing to a set of prepositions such as *into*, *through*, and *for*, Frayling relates research in the arts, distinguishing these three different modes by pointing out specific methods and objectives for each category.

The research *into* arts and design addresses historical and aesthetic aspects from diverse theoretical perspectives. Research *through* arts and design investigates new materials, the development of tools, procedures, techniques and what the author calls *action research*. This type of research corresponds to the activities performed in art labs and studios, it is based on practice and is characterized because...

...a research diary tells, in a step-by-step way, of a practical experiment in the studios, and the resulting report aims to contextualize it. Both the diary and the report are there to communicate the results, which is what separates research from the gathering of reference materials. (Ibid.).

Finally, Frayling identifies a type of research *for* Arts and Design not without recognizing that it is the most thorny and difficult to materialize within the academy. In fact, the author argues that in research institutes such as the London Royal College, the artistic results themselves do not constitute evidence of academic work: "...rightly or wrongly, we tend to feel the goal here is the art rather than the knowledge and understanding" (Ibid.).

Frayling's distinctions are pertinent because, although art works cannot be recognized as research results, on the other hand, the author seeks to identify and characterize modes of scientific work in the Arts and Design within a broader context of knowledge production. Furthermore, beyond purely theoretical activities, Frayling propose the concept of *action research*, in which artistic and design practices, usually carried out in the studio or laboratory are raised to the status of research.

2.2. The performative research

Not far from Frayling's concepts, the article entitled "The Manifesto for Performative Research", by Brad Haseman calls the attention to the emergence of a new way of dealing with research in the field of arts, media and design. The "practice-led research" emerged as an alternative to traditional quantitative and qualitative models, which would be under the influence of a tension between words and numbers, as paradigms of research reporting.

The practice-based research is identified by Haseman as performative, which in turn would be focused on alternative approaches, different from the traditional designing, conducting and reporting research.

Haseman further clarifies that the assumption that research should be divided between quantitative and qualitative evidences two major ways of conducting research. The author points out both distinctive and opposite aspects, not only regarding the research purposes, but also the mode in which knowledge is generated.

Quantitative research is more concerned with a set of deductive approaches and with establishing the boundaries of the problems from known theoretical models. According to Haseman, the knowledge production occurs as follows:

In ruthlessly testing such hypotheses, this research approach measures and quantifies phenomena, constructing them in terms of frequency, distribution and cause and effect. The ultimate goal is to isolate principles, which allow for the generalization of findings and the formulation of invariable laws. (Haseman, 2006: 1).

On the other hand, qualitative research has a tendency towards more inductive approaches that seek to cover a wide range of strategies and research methods, being able to include even the perspective of external participants. Thus, these two wide ways of conceiving research are not only related to different ways of creating knowledge, but also linked to the ways in which this knowledge is expressed. While quantitative research is an activity that seeks to express something from a point of view of calculus, qualitative research, in turn, is concerned with capturing the interpreted properties of behaviors and questions around all forms of social inquiry.

Although Haseman draws attention to certain similarities between the procedure of qualitative research and the one of practice-based research, the author also makes clear that it is a form of research that has its own characteristics regarding the way in which the process of acquisition of knowledge is conducted. For Haseman, since practice-based research is fully mature in its modes of operation, it can then truly emerge as a third way of possibility for performing arts research.

2.3. Affinity Communities of Musical Experimentation

The environment marked by a new perspective on the conduction of research, as described by Frayling and Haseman, is different from the traditional models since it resorts to performativity as a methodology. This alternative model makes use of experimental practices as a strategy to create, select, and re-signify poetic materials into artistic creations.

Thus, the concepts of experimentation, experimental and experiment are seen as recurrent strategies linked to forms of research based on practice, requiring, therefore, a deeper conceptual clarification. For this, it is worth mentioning the article "From Experimental Music to Musical Experiment" (1997), which is an influential text about musical experimentation. There, Frank Mauceri presents some of the most frequent uses of the term "experimental" - or "experiment" - reflecting not only on their implications and consequences but also on the divergence of meanings that arise when used without the respective contextualization.

Mauceri examines all of these questions in order to present his main proposal which he names as "experiment as heuristic" (Mauceri, 1997: 200), and which is based, briefly, on a practice open to the discovery of the unknown and the unpredictable, new ways of thinking: "The unforeseen musical event exceeds our ability to 'sense' of it; it breaks our interpretive framework." (Ibid: 201).

Another not mentioned but important issue is the social and cultural particularities of the researcher, the group of researchers, and the social context involved, which in many ways influence the research work. Thus, to clarify this important aspect, it is worth mentioning the article "Rethinking the Collective in Music" (2011), by the ethnomusicologist Kay K. Shelemay, who explores deeply the question of collectivity in musical practices and presents a very broad definition of the concept of "Musical community", capable of encompassing the contemporary collectives of musical creation with their particular community dynamics whose characteristics and origins are often multiple, complex and transdisciplinary.

According to Shelemay:

A musical community is, regardless of its location in time or space, a collectivity built and sustained by musical processes and/or performances. A musical community can be socially and/or symbolically constituted; the musical creation can give rise to social relations or it can exist almost exclusively in the domain of a virtual environment or in the imagination. A musical community does not require the presence of conventional structural elements or the need to be hosted in a single place, although both structural and local elements may assume great importance at some point in the formation or ongoing development of the community. Instead, a musical community is a social entity; the result of a combination of social and musical processes, making those who participate in the music creation or listening aware of the existence of a connection between themselves (Shelemay, 2011: 364-365).

The Shelemay`s definition of musical community seems comprehensive enough to encompass many of the issues we are dealing with. We highlight the important role given by the author to “musical processes and/or performances” in the construction and sustainability of these communities.

Thus, Shelemay proposes three basic processes in the formation of musical communities: descent, dissidence and affinity. In our case, affinity is clearly the most relevant, mainly because it involves closeness with the ideas discussed earlier about of musical experimentation.

Music proves to be a particularly powerful mechanism for catalyzing communities by affinities, in which objective aesthetics and personal preferences may, but need not, cross with other powerful elements such as ethnic identity, age grouping, or gender identity” (Ibid: 373).

Affinity communities may arise or be strengthened, for instance through accidental encounters. This type of contact “can trigger a lifelong relationship with a musical tradition that was not part of the subject’s life, providing a ‘conversion experience’ ... (Ibid: 373). According to Slobin, by joining a community with which he identifies himself, the individual belongs to a group of people “who have similar minds and who are magnetically attracted to a certain genre that creates strong expressive links.” (SLOBIN, 1993: 98).

Musical production, here called experimental, is extremely broad and refers to a way of thinking and a creation and performance practice rather than a well-defined aesthetic approach. The works, events, meetings, rehearsals and concerts created within this environment are “observable practices” whose shared values are discussed by the group at the moment they emerge. Such activities have a dual function: they act “as a potential force for cohesion and as a source of cultural effervescence. Music involves these two tasks [...], it pushes in one direction while seeking new individuals for its group” (Shelemey, 2011: 378).

As we shall see, the “Sons de Silício” event clearly carries this dual function. While it seeks to reinforce the activities of the GPI and the artists and groups that deal with the practice of experimental luterie, stimulating its production, also seeks to show the work of these individuals and groups to others who may feel affinity with the work or with the concepts developed there and can get involved with these groupings or with these issues.

2.4. Collective and collaborative creation and their presence in the Universities

A direct consequence arising from GPI-NuSom's collective activities is the promotion of collaborative artistic creation. The focus on this methodology has been fundamental in allowing both, the theoretical and practical work to cross disciplinary boundaries, extending the scope of practice beyond traditional infrastructures.

Such a procedure is increasingly adopted in academic research groups concerning with practical activities for artistic creation. According to Salles:

Regarding the discussion of collective creative processes, I can not fail to highlight the interesting overlap of teams that occurs, in many cases, in the academic field. They are theater, dance or music groups or film teams, congregated by the need for their artistic pursuits, and many of their participants are also active members of academic study groups. (Salles, 2017: 199).

Salles even highlights the activities of the current NuSom, particularly the performance Transparency, carried out in 2013¹, about which she says that "It is an interesting superposition of groups, that makes possible the interaction of academic research and the one involving contemporary artistic experiments with the support of funding agencies." (Ibid: 200).

In the current GPI-NuSom context, for instance, if a member of the group raises a technical issue about how to control a motor to achieve some previously imagined sound gestures; it will trigger a whole chain of reactions and discussions among the participants promoting collaborative practices as well. When each participant adds something around the initial question, based on his/her training, experience and knowledge, it gradually turns this question into something else, which is no longer the originally neither what the interlocutors proposed. It will become the fruit of the collectivity, which will yield more or less collaborative effort according to the collective interest, and not anymore to the desire of a single subject.

Collaboration goals need to be challenging enough to attract the interest and contributions of all the participants, as well as flexible enough to engage them to develop a shared collaborative vision about how to proceed, where roles can change and evolve while

¹ More information about Transparency can be found on the NuSom website: <http://www2.eca.usp.br/nusom/> and in "¿Música?" (Miskalo, 2014: 122-126).

In the last few years, artists and researchers concerned with artistic creation processes have come to focus on collaborative creative practices: “we gradually move from individual forms to collective forms of creativity ... to give shape to emotions and knowledge, science, art and technology” (De Masi, apud Salles, 2017: 35). A relevant example is the researcher Cecilia A. Salles, who discusses in her book, “Processes of Creation in Groups: Dialogues” (Salles, 2017), several characteristics of the artistic groups.

For Salles, the researches of the processes of artistic creation began to use less and less the idea of the artist as a creative genius to encompass all that which surrounds and which allows and stimulates its manifestations: “The individual itself has the form of a community [...]”. (Salles, 2017: 39). According to her, “the work develops in this emotionally tense environment, amid pleasures and dislikes, flexibility and resistance” (Ibid: 158).

This orientation towards a broader approach of the subject also helps in the theoretical approach of collective and collaborative works - such as GPI-NuSom - where these questions appear in a much more complex way:

In team processes, it is the grouping of subjects in creation, immersed in this whirlwind of sensations, in which two questions are considered as quite relevant. On the one hand, they are processes that do not happen if not in a team. [...]. On the other hand, this whirlwind of sensations of the subjects (as community) happens in the middle of a common search, living with the sensations generated by the interaction with the other members of the group (Ibid: 159).

Salles emphasizes the importance of the practice of experimentation in contemporary processes as a trigger for these reflections and, in the same way, highlights the importance of the universities that are “offering a very fertile space for artistic experimentation, which, in many cases, is maintained by fellowships” (Ibid: 196).

As a direct consequence of the latter, it arises the need for conceptualization and theoretical and critical foundation of this type of production, which feedbacks the very process of artistic creation in a continuous cycle of development.

The question of *methodology* becomes a challenge constantly discussed and debated in this context, after all they “(...) are works on their own processes of creation that, as has been said, need to bring out in a systematized way what we observe in all pathways: theory implicit in practice.” (Ibid. : 198).

Salles says she does not believe “that there are models to be proposed, but possibilities of paths to be thought, that brings to light that thought on the practice [...]” (Ibid.). She also warns: “It is necessary to look for methodological and theoretical procedures to escape from the reports of the process, that is, the narrative of the changes and choices made along the way.” (Ibid.).

2.5. Intersections between Art and Science

According to Born and Barry (2010: 104), art-science goes beyond the term’s traditional sense, which implies making scientific knowledge available through art. Instead they propose art-science as part of a larger and heterogeneous space where interdisciplinary practices overlap at the intersection of the arts, sciences, and technologies. They correspond to a set of changeable relational and growing categories. That is, art-science is also a dynamic and ever-changing process.

Three types of logic are identified in this interdisciplinary field: accountability, innovation and ontology. The first two can be quickly understood: accountability is relevant for science since it should be trusted and credited the public; innovation places scientific research as an indispensable tool for industrial, commercial and economic development. The Ontological logic, on the other hand, is concerned with practices promoting changes both in the objects of research and in the relations between research subjects and objects.

According to the authors, in the book “The Two Cultures” (1959) C.P. Snow pointed to a cultural division between art and science, suggesting that overcoming the latter would have favorable economic implications. On the other hand, for Raymond Williams, author of *Culture and Society* (1958), the problem was the indifference of intellectuals and scientists towards popular forms of cultural knowledge and practice.

In the 1990s and 2000s, interdisciplinarity between the arts and sciences grew not only with the idea that the political elite should know more about science but also with the idea of rethinking the relationships between

science experts and the public. In addition, Williams's attention to the history of cultural forms points to the importance of framing any analysis of art-science in terms of the history not only about the links between science and the public (Nowotny et al, 2001) but also about links between art and the public. As Born and Barry suggest: if, on the one hand, art-science was supported by funding institutions, on the other, the genesis of this field occurred:

... in the mutual disturbances or interferences thrown up at the intersection of three distinct but related genealogies. The first is conceptual and post-conceptual art, including performance, activist and installation art; the second encompasses historical art and technology movements, as they issue in the multi-, inter- and trans-media arts of the present; and the third comprises, broadly, developments and debates around the computational and bio sciences and technologies. (Born et. al. 2010: 110).

3. GPI-NUSOM - RESEARCH PRACTICES

The Group of Interactive Practices (GPI) is a research group that works within the Research Center of Sonology at the University of São Paulo (NuSom-USP). Although NuSom was formalized only in 2012, its founding nucleus was already active at USP, seeking to structure these areas of study about a decade ago (Miskalo, 2014: 14-16). Despite the fact that GPI is part of NuSom and some of their members have followed all its trajectory, it is a recent subgroup created only a year ago with a much more specific goal than NuSom's comprehensive work. GPI is dedicated to practical projects. Mainly projects involving research, development and manufacture of instruments and mobile devices, autonomous and with audio operations that consider such concepts as sound experimentation, internet of things and computational ubiquity.

From weekly meetings held over a period of one year at USP's Music Department, we sought to delve deeper into topics such as Experimental Lutherie and Sound Art, exploring recent computing and electronics inputs for the prototyping of technological devices such as Arduino, Raspberry Pi and ESP8266². Thus, during our process we tested an array of sensors and microcontrollers available in the market, in an investigative search interested in transforming them into artistic instruments. Concerns such as

² These are electronic prototyping technologies of hardware and free software that have an integrated circuit (IC) embedded in a single plate. They use a microcontroller that contains digital and

portability, audio processing and low-cost implementation come to take relevance in our artistic works.

Our experiences with unknown (to us) technologies – or at least little explored by us – was at the same time a guiding aspect of the research and also a generator of technical challenges for the group to solve together. The treatment of these devices triggered several technical and aesthetic issues faced by the sum of ideas debated among the participants, each with its specific artistic and academic training. This kind of poetic crossing inserted by the technological resources occurred in a purposeful way, however, strongly marked by procedures of experimental character, not only in what concerns the creation of knowledge, but also in relation to the presentation of the results obtained.

When exploring technical potential of certain equipment, we usually came across an aesthetic question to be solved, called by the group as “output problem”. This is an intermediate stage of research development where important definitions of compositional scope and sound identity of the project occur. The “output problem” thus refers to the compositional moment in which some type of relationship is established between a set of data captured by a certain sensor (input) and its output correspondence. It is a delicate moment that involves all kinds of creation concerning directly the sonic material.

As an example, it is worth mentioning our research with accelerometers, which is a sensor capable of measuring the acceleration of their movements in space. The device provides an analogue reading of offsets from the x, y, and z axes. The accelerometer was used on the body of a musical instrument - trombone - to take advantage of the instrument’s gestures to generate correspondence between gesture and sound. It is precisely at this moment of research that the “output problem” emerges strongly and consequently requires reflection and the proposition of creative solutions.

analog input and output brackets, facilitating their code-oriented programming. Thus, through the analog and digital pins it is possible to easily connect a series of electronic components.



Fig. 1: Some members of the GPI during a technical visit to the *Sons de Silício* exhibition space. We took advantage of the meeting to perform tests with the instrument created for the piece *Risicare*.

3.1. Re-use and *gambiarra*

Aware that GPI-NuSom activities are located in a peripheral environment because of knowledge geopolitics, our work relies on the operational concepts of other artists and designers who share the same condition. Topics such as reuse, repair and *gambiarra* present themselves in the practices of the group as strategies to deal with asymmetry in the conditions of access to tools and the precarious conditions of technological development in our region.

According to Cuban artist and designer Ernesto Oroza, the reuse and repair of technological devices can become an act of empowerment if we think that in doing so, we produce an imbalance in the dependency adopted before them as consumer products. When they are fixed, objects are re-signified in a position of subordination. Thus, it can be said that reuse and repair are acts of technological disobedience that allow the preservation of objects while retaining their original functions. By knowing the technical secrets of the product, the doors to processes like the one of refunctionalization, and the reinvention are also opened (Oroza, 2012).

In the Brazilian context the notion of *gambiarra* is also popular in discourses involving art and technology and is a striking concept in the production of experimental music. In the context of the arts, the term *gambiarra* refers to "... an improvisational method of working with materials, devices, technology and / or institutions" (Giuliano Obici, 2017). The term is commonly used to refer to the action of repairing, in an alternative and unorthodox way, any kind of problem. Giuliano Obici has shown that the notion of *gambiarra* is not only Brazilian and that it can be confronted in a global context. He describes a series of expressions in other countries with near or equivalent use to *gambiarra*: *revolico* and *rikimbili* (Cuba); *rasquache* (Mexico); *chapuza* and *arreglo temporal* (Uruguay); *solución parche* (Chile); *arreglo hechizo* or *reparación hechiza* (Colombia); *desenrascar* (Portugal); *jugaad* (India, Pakistan and some African countries); *jua kali* (Kenya); and *zizhu chuangxin* (China) (Obici, 2017: 88).

In GPI-NuSom the notions of re-use, repair and *gambiarra* have been useful to guide the creative processes. In meetings the group often shares individual experiences of the participants with the tools and materials adopted. This sharing of *gambiarras* and tricks constitutes an important element of motivation for the cohesion and strengthening of the research group.

The application of these concepts is easily identifiable in the practices of our group. Not only in the dismantling of equipment to the use of its motors, components and/or gears, but also in the refunctionalization of some equipment. A very simple example is the use of the cheap earphones that accompany cell phones as microphones to test audio connections and audio input into software such as Pure Data and Sonic Pi. Certainly, the manufacturers of earphones did not intend such use. But in the absence of specific microphones during experimentation and its technical characteristics – in addition to being always present – this type of earphone works very well as a microphone for our purposes.



Fig. 2: Alternative use of earphones as audio input device on Raspberry Pi.

It can be said that this type of technological disobedience is usually more related to the lack of materials, than to artistic motives. It should be noted that the group does not have a regular budget for equipment. However, it is procedures such as these that have contributed to the progress of research and overcoming technical problems of various kinds. Although this type of procedure may reveal a certain level of precariousness, it may also contribute to the emergence of ideas and procedures previously not considered. Thus, we conclude that the concepts mentioned above represent for the GPI-NUSOM, not just a singular way of solving technical problems, but also a recurring and desirable procedure for conducting research our practice.

3.2. Appropriation of portable technologies

The preference for the use of portable technologies by GPI-NUSOM is related to the fact that they allow the artistic works to dialogue with different exhibition and performance spaces. After several experiments we ended up adopting the ESP8266 microcontrollers and Raspberry Pi as the electronic prototyping platforms most suitable for some of our purposes, especially for offering wi-fi communication capabilities.

From our experiments, we also conclude that the use of these resources allows the presence of a satisfactory level of portability, while guaranteeing

both the processing power and the low cost of production.

We can say the search for portability in the artistic works led the collective to study and master forms of wireless data communication through the creation of a local network using communication protocols such as UDP processed in Pure Data. Thus, some of the creations of the group culminated in the use of a certain sensor as input of signals transmitting data between ESP8266 and Raspberry Pi.

3.3. Adopted Methodologies

Another methodological resource used in our process was the virtual tools of cooperation among the members - such as the Moxtra, GitHub and Google Drive platforms - that not only allowed the elaboration of tutorials and codes, but also provoked reflections on issues of collective processes and links necessary for the creation of a collaborative creation environment.

This condition resembles what we defined in the first part of the article as a research based on practice for meeting methodological criteria interested in expressing its results “in non-numerical data, and in forms of symbolic data other than words in discursive text”.

If we think of Frayling’s categories regarding GPI-NuSom’s laboratory practices, we find that our practice-based research activities lie on the frontier between research *through* and *for* arts and design. On the one hand, the group has produced documentation that shows the discussions that took place in regular meetings during a year. Reporting on activities has also been a priority. These two aspects approximate the group’s activities of research *through* arts and design, particularly to the concept of action research proposed by Frayling. On the other hand, the group has been busy creating works of art and encouraging the creation of works of art among other NuSom colleagues and other Art and Technology groups at the University of São Paulo which adopt artistic, technological and artistic-scientific processes. This brings us closer to research *for* the arts and design.

3.4. Results. The Sons de Silício art exhibition

After one year of regular meetings, our journey achieves the end of its first cycle by organizing and curating the exhibition Sons de Silício, seen by the collective as a particular way of carrying out the research reporting.

In October 2018, we make a call through the NuSom email list as well as other email lists concerning Arts and Technology in the University of São Paulo with the following invitation:

Open Call. The 15th version of *¿Música?* presents the Sons de Silício Exhibition, which will be held between the 1st and 26th, April 2019 at the São Paulo University's Espaço das Artes. The exhibition addresses the topic of Experimental Luterie, as the integrative concept gathering music, visual arts and computer science practices and as a catalyzer of new modes of experimentation with sound and technology, such as Gambiarra, Sonic Interaction Design, Auditory Displaying and Sonification.

For one month the Espaço das Artes will become the meeting and discussion place of Experimental Lutherie practices. As organizers and curators of the exhibition, we kindly invite artist and makers to develop instruments, objects, installations, machines and/or sculptures that propose unusual ways of interacting with sound by engaging the visitors to question listening as a strategy to explore and recognize the world. Performances, workshops and lectures are also welcome, they will be carried out during the exhibition's duration. The call is addressed to NuSom former and current members as well as other groups from the University with relevant works in the field (GPI-NuSom, 2018).

We selected 22 installations, 10 performance and three workshop proposals. It is worth mentioning that some of the works provided resources for the exhibition. Particularly, the InterSCity project supplied the budget allowing us to bring to the public arena some of the knowledge that is being produced by current research projects in the University.

As a sample of both, the Sons de Silício Exhibition and the results obtained by the group we will describe the creative insight of two installations created by GPI-NuSom members.

3.4.1. Red Line

According to our critical analysis on the practical works, it is worth clarifying how was incorporated the technical and poetic aspects. Red Line is an interactive installation of light and sounds formed by lasers that cross the space in several directions forming a kind of web or entangled of luminous lines. The laser points are directed to light sensors that trigger different sounds at the exact moment the trajectory is interrupted. The poetics of the installation seeks a performative and interactive environment

where the sounds are triggered by different gestures under the lasers. In practical terms, the variation of luminosity occurs when the interactor intercepts the laser point with the movement of the arm or with the simple walk inside the installation.

The triggering of sounds occurs from programming in a Pure Data patch processed by Raspberry Pi. The device operates with the aid of a wireless communication network that collects and transmits the data of luminosity variations of the ESP32 microcontroller to the Raspberry Pi.

The installation was consolidated in a version updated by the group and directly influenced by the collective desire to insert aspects such as mobility and interaction in the poetics of artistic works. Thus, Red Line could be modified by the aid of the technologies involved, which allowed the exclusion of the wire connections, collaborating to optimize the interaction with the public, and the adaptation of the work to other exhibition spaces.

3.4.2. Sonhophonias

The PBP related to the creation of Sonhophonias (2019), has as a challenge the sonification of the EEG data of a polysomnography (record of data collected on an individual's night's sleep), and presents as characteristic related to the new paradigms of the research on the arts, the indeterminacy of results and non-linearity of the process of structuring the work, as we saw at the beginning of this article.

The sonification process of a Dataset of the various EEG sensors, also implies the unfinished condition of the results and will be re-evaluated whenever we learn more about the nature of such data. The more details about the data we know, the more possibility of representation relating sounds to specific events extracted from the Dataset. Thus, the sound produced gains other meanings in a dynamically seemingly endless process.

Consequently, the development of the work, which encompasses both the sonorous processing of EEG data and the live or audio narration of the referential dreams of Carl Jung's (2017) work, recorded in The Red Book, is an example of "2 of knowledge production" (NOWOTNY, et al., 2001), in establishing the multidisciplinary connection of areas such as psychology and neuroscience. This connection occurs through the common goal of the two processes that is summed up in promoting the transformation of activities of the human unconscious into sounds. In this sense both the processing of the EEG data through the computer translating them into sounds, corresponds to the procedure of the narration of the descriptions

of some of the dreams determining to the research on the understanding of the unconscious processes of the great psychologist. The combination of the two processes in a performance / installation, aims to promote a third layer of understanding of the first two, an aesthetic experience, sensory and reflective also for both the public and ourselves.

In addition to the challenges of the interdisciplinary connection between Neuroscience and Psychology and its consequent integration into an aesthetic experience with artistic intentions, there is also the question of precariousness as a characteristic of Latin American research production. The production of this work involves the technological challenge of processing a huge amount of data for a four-channel installation of sound through low-cost computers, Raspberry-Pi.

In this sense, we have the co-creation of the work done by Julian Jaramillo in the structuring and technological adaptation of the work, and collaborations of Professor Silvio Ferraz, and members of GPI-NuSom (Esteban Viveros, Fabio Martinele, Vitor Kisil).

The realization of this work does not properly present the interactive character that marks the production and the objectives of GPI-NuSom but is inserted in the context of Art-Science (BORN & BARRY, 2010) and in the developments and debates around computer technologies and biosciences.

4. FINAL CONSIDERATIONS

Prospects for the future are to strengthen both the theoretical basis and the practical achievements increasing the number of active participants and dialogue with other artists-researchers and groups. The occupation “Sons de Silício” operates in all these directions, boosting both the drafting body parts, as the deepening of the conceptual issues involved and the interaction with other artists. It also assists along with this article, with the group’s history of registration and the creation of their traditions, which can now be adopted by others who share an affinity with the issues involved.

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