TAXONOMÍAS Y CLASIFICACIONES DE INSTRUMENTOS Y SISTEMAS ELECTRÓNICOS: UNA VISIÓN HISTÓRICA Y PERSPECTIVAS DE FUTURO

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Resumen
La autora traza la historia de las taxonomías y clasificaciones de los instrumentos musicales electrónicos. A comienzos del siglo XX estos instrumentos son descritos por primera vez, dentro de los mismos sistemas por los que se describían los instrumentos acústicos, conforme a sus cualidades morfológicas. Seguidamente, se explica que las siguientes clasificaciones están formuladas desde una perspectiva más rica -desde la del intérprete de música, de la audiencia y de los diseñadores de instrumentos- e intentan describir características más interesantes de los instrumentos musicales electrónicos. Por último, la autora plantea la necesidad e importancia de que sea formulado un sistema de clasificación más preciso para los instrumentos y sistemas musicales electrónicos.

Palabras clave: NIME, lutería electrónica, organología, instrumento electrónico, música de interactivos

TAXONOMIES AND CLASSIFICATIONS OF ELECTRONIC INSTRUMENTS AND SYSTEMS: AN HISTORIC OVERVIEW AND PROSPECT OF FUTURE

Abstract
The author traces the history of taxonomies and classifications of electronic instruments. At the beginning of the 20th century these instruments are firstly described, within the same systems that the acoustic instruments were, according to morphological characteristics. Next, she explains that the next classifications are formulated from a richer perspective - the performers, the audience and the instrument designers - and try to describe the characteristics of the electronic musical instruments involved in artistic practice. Finally, the author discusses the need and relevance of formulating a precise classification system for electronic instruments.

Keywords: NIME, electronic lutherie, organology, electronic instruments, interactive music

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INTRODUCTION

Taxonomies derived from Hornbostel-Sachs[335] system are satisfactory for cataloging and organological classification, but are not fully effective to allow for a descriptive classification serve as useful for the work of professionals involved in the practice of design, creation and electronic music performance tool.

We will travel through the history of these and other classifications proposed in the twentieth and twenty-first centuries and through its various typologies -as can be depending on the mapping[336] , the kind of input[337], the types of interaction[338] and so on-, looking for one that facilitates making descriptions and comparisons between the different instruments and interactive music systems, in order to contribute to heritage conservation, and the documentary memory of the old electronic instruments, in addition to create better ones, designed from an appropriate knowledge of the history of electronic lutherie.

TAXONOMIES AND CLASSIFICATIONS

Francis Galpin is the first organologist who, in his work *A Textbook of European Musical Instruments*[339] calls the group of musical devices where the electricity intervenes, when this practice electronic lutherie was still in its infancy, and its consolidation over time in the compositional and performance practice was still in question. Curt Sachs integrates therefore the development of tools that operates

[335] Erich von Hornbostel & Curt Sachs «Systematik der Musikinstrumente», *Zeitschrift für Ethonologie*, no. 46, 533-590, 1914.
[336] Tellef Kvifte, *Instruments and the electronic age*. 2ª, Oslo, Taragot Sounds, 1989.
[337] Bert Bongers, «Physical interfaces in the electronic arts interaction theory and interfacing techniques for real-time performance», *Trends in Gestural Control of Music* [on-line], vol. 2000, no. January, 41-70, 2000. Available at: http://emerald.tufts.edu/programs/mma/emid/IRCAM/Bon.pdf. (Accessed 5 July 2019); Claude Cadoz & Marcelo M. Wanderley, «Gesture-music», *Trends in Gestural Control of Music* [en línea], París, IRCAM - Centre Pompidou, 71-94, 2000. Available at: http://www.idmil.org/_media/wiki/cadoz_wanderley_trends.pdf?id=publications&cache=cache. (Accessed 15/5/2019).
[338] Joel Chadabe, «The limitations of mapping as a structural descriptive in electronic instruments». *Proceedings of the 2002 International Conference for New Instruments for Musical Expression (NIME-2002)* [on-line], pp. 1-5. 2002. Available at: https://pdfs.semanticscholar.org/4751/10b3403a9344464ae869748be56469d88cf8.pdf. (Accessed 21/5/2021); Atanau Tanaka, «Musical performance practice on sensor-based instruments», *Trends in Gestural Control of Music* [on-line], no. Laurel 1990, pp. 389-406, 2000. Available at: http://www.csl.sony.fr/downloads/papers/2000/AtauIRCAM.pdf. (Accessed 1/9/2020).
[339] Francis William Galpin, *A textbook of european musical instruments: Their origin, history and character*, Londres, Williams & Norgate, 1937.

electricity in the *History of Musical Instruments*[340], and also heirs the early ethnomusicology division by Mahillon[341].

This methodical classification of musical instruments is made in its root categorization, according to the material of the transmitter conforming the four families of acoustic instruments and it is subdivided into a tree, leading to a coding in Dewey decimal system.

The system of Hornbostel and Sachs (hereinafter called as H-S system) is so solid that, although it has received different questions, improvements and updated over the hundred years that remains in use today in the discipline of organology and museum sciences. Michael B. Bakan, Wanda Bryant, Guangming Li, David Martinelli and Kathryn Vaughn[342] advance in the classification of the electrophonic group of the H-S system, as does Hugh Davies[343]. The most recent exhaustive review of the H-S system with a great completion of the electrophones group, has been recently done for the Musical Instruments Museums Online[344].

Montagu and Burton[345] made a new approach transliterating the system of Linnæus used by Natural Sciences. A major advantage of this proposal is that the term used to designate each particular instrument is only two or maximum three words long, which is easier to retain and identify than a complex multi-numeric code as Dewey's. This system is apparently different than the H-S but in its essence, it is another classification of the physic matter of the instruments. Currently regarding to the subject of this research, the Montagu and Burton classification excludes the musical instruments that operates on electricity.

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[340] Curt Sachs, *The history of musical instruments*, New York, Norton, 1940.
[341] Victor-Charles Mahillon, *Catalogue descriptif et analytique du Musée Instrumentale du Conservatoire Royale de Musique Bruxelles*, 2ª, Bruselas, T. Lombaerts, 1893.
[342] Michael Bakan et. Al. *Demystifying and classifying electronic music instruments*, S. l.: s. n., 1990
[343] Hugh Davies, «Electronic instruments», *New Grove Dictionary of Musical Instruments*, E. Sadie (ed.) Macmillan, 1984; Hugh Davies «Electrophones», *New Grove Dictionary of Musical Instruments*, E. Sadie (ed.) Macmillan, 1984.
[344] Stephanie Weisser & Maarten Quanten «Rethinking musical instrument classification: Towards a modular approach to the Hornbostel-Sachs system», *Yearbook for Traditional Music*, *International Council for Traditional Music* [on-line], vol. 43, pp. 122-146, 2011. Available at: http://www.jstor.org/stable/10.5921/yeartradmusi.43.0122?seq=1#page_scan_tab_contents (Accessed 3/9/2020).
[345] Jeremy Montagu & John Burton, «A proposed new classification system for musical instruments», *University of Illinois Press on behalf of Society for Ethnomusicology* [on-line], vol. 15, no. 1, pp. 49-70. 1971. Available at:: https://www.jstor.org/stable/850387 (Accessed 1/9/2020).

Tetsuo Sakurai[346] thinks again the categorization of electronic musical instruments also in reference to the kind of material that begins the process of vibration and sound, and makes a division based on the geometric shape of the body of the musical instrument.

Lysloff and Mattson[347] increase the amount of classification variables up to 37, the first of them, from first to twenty-second, are about material and mechanics just joining the preceding classifications, but therefore they state other variables to describe some interesting aspects of the instruments for the player and their relationship, compositional subjects, and still other variables to describe the context in which the instrument is played. The main advantage of this approach is its ability to show the similarities of the instruments that seemed remote after the first categorizations in the preceding taxonomies by interrelating the variables in a graphic-analytic presentation of the description.

The theorization of these organologists within a classification approach linked to the tradition of the beginning of the 20th century is from an external point of view to the praxis of music. From the 70', those who have theorized about the creation of electronic musical instruments by proposing ontologies, taxonomies or classifications have been mostly the pioneers of design and development of such instruments. Some of them are Hugh Davies, Gil Weinberg, Bert Bongers, Joseph A. Paradiso, Joel Chadabe, Alain Crevoisier, Garth Paine, Michel Waisvisz, Marcelo M. Wanderley, Jeff Pressing, Robert Rowe, Nicolas Collins or Tellef Kvifte. All these highly active researchers of instrument building have in common that they join the tasks themselves of theorist of music, electronic luthier, composer, and player.

Some theorists elaborate morphologic classifications close to anyhow to the H-S tradition. In this way, the classification of Paradiso[348] is a division of non-excluding categories at all respect to the morphology and interpretative technique of the music

[346] Tetsuo Sakurai, «The classification of musical instruments reconsidered», *Proceedings of the 26th Conference of the International Folk Music Council* [en línea], pp. 824-830. 1981 Available at: http://www.jstor.org/stable/852139?seq=1#page_scan_tab_contents (Accessed 14/4/2020).
[347] René T. A. Lysloff & Jim Matson, «A new approach to the classification of sound-producing instruments», Pegas HS, Ethnomusicology [on-line], vol. 29, no. 2, pp. 213-236. 1985. Available at: http://www.jstor.org/stable/852139 (Accessed 14/4/2020).
[348] Teresa Marrin & Joseph Paradiso, «The Digital Baton: A versatile performance instrument», *International Computer Music Conference (ICMC)*, no. 1, pp. 313-316, 1997.

interface. This fact places his classification in the same line deriving from the H-S, but this classification also includes the division analog to the music acoustic instruments, keyboards, percussion, guitars, batons and so on– but additional type of instruments assorted according to the input, as non-contact gestures, wearable and tactile. Wanderley[349] has done morphologic classifications in function of the similarity with traditional instruments, so as the classification sketched out by Vine[350].

Given that the authors of the classifications of this age make their research from the perspective of the Arts, they assume the point of view of those roles implied in music creation as the luthier, the composer-player and the listener. Therefore, we find as main criterion of classification the construction quality, performance capability, and aesthetics.

Some classifications were written focused on mapping in order to explain the relationship between player and music instrument. Tellef Kvifte[351] classified the music instruments from the point of view of the player, because he described in detail the description of the instruments combining each playing mechanism that they have with three sound variables: frequency, volume, and tone. He qualifies each one as analogic or constant, and discrete or digital. This description is deeply rooted in the cause-effect of the player's musculature and the resulting sound of an acoustic instrument, which can be applied to the electronic instruments with a simple or literal mapping. This description is focused on mapping but finds difficulties to describe the musical systems in which the cause-effect relation is confused, non-direct or merely non-existent. Therefore, newer classifications have included this variety in reactions of the machine respect to the player[352].

[349] Marcelo M. Wanderley, «Gestural control of music», *Supervision and Control in Engineering and Music* [on-line], 14. 2001. ISSN 00063002. Available at: http://recherche.ircam.fr/equipes/analyse-synthese/wanderle/Gestes/Externe/index.html%5Cnhttp://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.137.9460&rep=rep1&type=pdf (Accessed 3/4/2020)

[350] Bill Vine, «Avoiding extinction in the instrument zoo: A taxonomical and ontological approach to developing an understanding of the ecosystem of electroacoustic instruments», *Organised Sound* [on-line], vol. 15, no. 2010, pp. 167-177. 2010. ISSN 1355-7718. DOI 10.1017/S1355771810000166. Available at: https://www.cambridge.org/core/journals/organised-sound/article/avoiding-extinction-in-the-instrument-zoo-a-taxonomical-and-ontological-approach-to-developing-an-understanding-of-the-ecosystem-of-electroacoustic-instruments/BCD79C9A9AB2A42E3B6E878247D15AB (Accessed 2/9/2020).

[351] T. Kvifte, *Instruments and the electronic age...*

[352] J. Chadabe «The limitations of mapping (…)».

The main motivation to elaborate the works of these authors, articles, books, and papers, is to send a feedback to the electronic music instruments designers, offering to the builders and manufacturers a pre-evaluation of the devices by which they will be able to predict some aspects as the acceptance by the players, the perception of the public, or the composition paradigm for which it is the most adequate.

Some of these types of classification are adaptations of the models of non-musical human-computer interaction (HCI) to the music needs. This is the case of the approaches of Jeff Pressing[353] and Wanderley and Orio[354]. They evaluate in their works some factors about usability, efficiency, learning easiness and others. Moreover, the evaluation of sensors, and those gestures that the player must effectuate are implied. Some authors have studied thorough the different sort of instrument inputs (sensors) and human inputs (analysis of the gesture) that excite the instruments[355]. In this line of research of multiple factors, Laurie Spiegel[356] made an open proposal to describe the classification in a multiple-axis system, sixteen in her approach, to show in a quantitative or estimative way –mostly technical. The sixteen axes are referred to interpretative matters, so as to specifically technical, interpretative, and compositional related to the design and working of the music instruments.

Developing this type of evaluations and classifications has meant an improvement, because the authors have reformulated the subjects of evaluation. Firstly the perception and human movement theories by adding the material subjects to the sociologic and aesthetic and morphologic subjects[357]. This kind of diverse-analysis was focused later in the research of the greatest artistic value of the music instruments and

[353] Jeff Pressing, *Cybernetic issues in interactive performance systems*, S. l.: s. n. [on-line], 1990. Available at: http://www.jstor.org/stable/3680113. (Accessed 14/9/2019).
[354] Nicola Orio, Marcelo M. Wanderley et al. «Input devices for musical expression: Borrowing tools from HCI», *Proceedings of the 2001 International Conference for New Instruments for Musical Expression (NIME-2001)* [on-line], 15-18, 2001. ISSN 0148-9267. DOI 10.1162/014892602320582981. Available at: http://www.nime.org/proceedings/2001/nime2001_015.pdf. (Accessed 10/3/2019).
[355] B. Bongers, «Physical interfaces (…)»; C. Cadoz and M. M. Wanderley «Gesture-music».
[356] Laurie Spiegel, «An alternative to a standard taxonomy for electronic and computer instruments», *Computer Music Journal* [on-line], vol. 16, no. 3, 1992. Available at: http://retiary.org/ls/writings/cmj_taxonomy.html (Accessed 1/9/2020).
[357] Tina Blaine and Sidney Fels, «Contexts of collaborative musical experiences», *Proceedings of the 2003 International Conference for New Instruments for Musical Expression (NIME-2003)* [on-line], pp. 129-134, 2003. ISSN 0929-8215. DOI 10.1076/jnmr.32.4.411.18850. Available at: https://www.etc.cmu.edu/projects/jamodrum/spring04/Nime03BF.pdf (Accessed 4/4/2020).

their use in music[358]. There is a point of contact between these different types of classifications: the description of graphics of the music systems. Therefore, they create some common frameworks in which the authors can describe the relations between the agents involved, designer-manufacturer, player-composer, and listener as Bongers explains[359]. These frameworks make models of the interactive systems in which taxonomies can be formulated.

These models are getting more inclusive and wider, in such way that they have opened the concept of music instrument itself in a way that boards the greatest amount of different kinds of music systems[360], from the 'traditional' act of music in a temporal and spatial concert hall to the formulation of those expanded in space (global ones, networks, and so on) and in time. Some authors like Chadabe, Weinberg or Jordá make very interesting classifications based on 'metaphors' that simplify the phrasing of the different types by joining some varied features. These classifications are not exhaustive, but showing only partial aspects, as potential of complexity, and monitoring an instrument, type of network and its function in musical system, and the response of the system to the input of the user.

CONCLUSIONS

As we mentioned at the beginning of this written work, the classifications of morphological types, such as, Hornbostel-Sachs System (H-S) and similar, are useful

[358] Sergi Jordá, *Digital lutherie crafting musical computers for new musics' performance and improvisation* [on-line], S. l.: Universidad Pompeu Fabra, 2005. Available at: http://mtg.upf.edu/system/files/publications/Jorda-Sergi-PhD-2005.pdf (Accessed 26/2/2019); Atanau Tanaka, «Musical performance practice on sensor-based instruments», *Trends in Gestural Control of Music*. Laurel, p. 389, 2000; Roel Vertegaal et al. «Towards a musician's cockpit: Transducers, feedback and musical function», *Proceedings of the International Computer Music Conference* [on-line]. S. l.: s. n., pp. 308-311, 1996. ISBN 1026-1087. Available at: http://quod.lib.umich.edu/i/icmc/bbp2372.1996.093/--towards-a-musicians-cockpit-transducers-feedback-and-musical?view=image (Accessed 5/10/2019); Michel Waisvisz, «Panel discussion moderated by Michel Waisvisz: Manager or musician?. About virtuosity in live electronic music», *Proceedings of the 2006 International Conference on New Instruments for Musical Expression (NIME-2006)* [on-line], pp. 415, 2006. Available at: http://recherche.ircam.fr/equipes/temps-reel/nime06/proc/nime2006_415.pdf (Accessed 1/9/2020).

[359] Bert Bongers, *Interactivation: Towards an ecology of people, our technological environment, and the arts* [on-line]. S. l.: Vrije Universiteit Amsterdam, 2006. Available at: https://bertbon.home.xs4all.nl/downloads/PhDThesisBertXS.pdf (Accessed 3/10/2019).

[360] Robert Rowe, «Interactive music systems: Machine listening and composing», *Computer Music Journal*, vol. 17, p. 76. ISSN 09611215. DOI 10.2307/3680548.

only when a musical instrument is used as a physical object. This is interesting for areas such as Museum Studies or Iconography, in which it is not crucial to extract the details about the qualities and technical and artistic performances. However, this type of classification is not important for the professional needs of luthiers, composers, performers or traditional authors. The alternative for a taxonomic classification (categorical) is a descriptive multilevel or an axis system type. Some of them are very interesting according to methods and results. None are sufficiently satisfactory as to achieve their goals, because they are partial in their description areas.

According to studies of the large variety of musical instruments taxonomies, the conclusion is focused on the lacking of a homogeneous and stablished criterion, which can be used by practical musicians, instruments designers, composers, musicologists in order to use, design, develop or classify, compare and evaluate the electronic music devices. It is a specific case inside the set of musical instruments. The above-mentioned group of professionals would need a classification of detailed descriptions and features.

The clarity of how an instrument is described, helps musicians and researchers to reach a higher degree of comprehension of the instrument, awakening their interest on it and facilitating the acceptance by performers. Moreover, it can be kept as an artistic and patrimonial object. After the analysis of these classifications, which are thoughts about the constitution of the 'instrument', I am certain about the following conclusions. Firstly, it is useful to manage a wide idea about the instrument, because the boundaries between their typologies are unclear and this enactment would be random and not much operational.

That conceptual overflow happens in the parameters of spatial, temporal and even operative dimensions: an instrument can exceed the size of a scenic element. It can move to a room, and even surpass the whole planet, as a network. It can act not only at the moment of the concert, but it can happen during the time in which is being installed, or even it can be a musical device with a role of being permanent.

And all of them, even so divergent instruments, respond to the definition in a simple way, where 'musical instrument' is a device with human input, which enables to create an artistic sound proof. The features and performances of the instrument have an impact on the compositional parameters of the music obtained. For their detailed

description, the classifications are based on metaphors, which show this complex connection in a direct and simple way.

Reviewing the taxonomies, it is checked as a logical consequence to take into consideration the accurate classification, keeping in mind the previous achievements of results. In short, an accurate classification should have certain features. According to the previous review, putting in their context the classification and its features with the needs and possibilities of this time is fundamental.

The rules for developing a comprehensive taxonomy should be located in the historical moment where the classification is made, considering the previous others made by other authors. But attending the current concerns as regards their sorting and the technical features of the instruments themselves.

The performance of a new classification should not replace the updated Hornbostel-Sachs (H-S) system classification of electrophones –as Weisser and Quanten´s, which is simple, coherent with a continuation of the classification of traditional instruments and it is universally recognized, too. On the contrary, it should facilitate the data collection, which are not included in a cataloging of type H-S and they are needed by researchers, designers of electronic instruments and electronic performers.

The difficulty in a classification of this variety of receivers is clear because of the different interests of each group. The classifications studied in the technical papers are often focused on particular features of the electronic instruments, therefore they are partial. Achieving a classification system or a definitive categorization would be a dream. However, a wide categorization could be described as a goal for the different groups, as follows, clear for getting a quick and accurate concept of each classified 'item', avoiding that the understanding of each one as a new research in itself. And also a versatile one for making easier its future adaptation to the new advancements in technology and artistic future in this field.

Designing the structure and the content of the classification, it would be advisable to follow the criterion of collecting data about the performances and the use of instruments which are more useful for a complete technical description focused on the theory of musicology studies -historical research- and our artistic research.

Moreover, it would be ideal to meet objective requirements, to be organized in an accurate way in search of clarity and avoiding the excessive multiplicity, which allow to proceed with the current and future possibilities. The mentioned classification is directed to professionals with a certain field of study, musicians, such as, organologists, musicologists, performers, composers and instrument designers. And it allows a comparative study of the features of each device, offering the possibility of obtaining statistics, too.

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