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TÁBUA MOBILE, A MUSICAL INSTRUMENT DESIGNED FOR MULTIMEDIA PERFORMANCE

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Tábua Mobile is a musical instrument designed for multimedia performance. It consists of a table with two plain wooden boards; the upper board - in which objects and electronic devices are manipulated - is amplified using three types of sensors: piezoelectric pickups, guitar pickups and electret microphones. In the other board is placed the electrical part of the instrument, a mixer and the objects and electronic devices to be used. The objects are recontextualized everyday items, resignified both as sound producing and as aesthetic objects. Electronic devices include oscillators and noise generators. *Tábua Mobile* was designed as an extended instrument, so that the performances using it involve a concern with visual elements and with the theatrical relations established between the performers and the objects. This paper introduces the instrument, traces its antecedents, makes a full description of it and its accessories, displays a brief discussion about the ideas concerning *Tábua Mobile* and the performances using it, and report future implementations.

1. Introduction

Tábua Mobile (version 1.0) is a musical instrument designed for multimedia performance. It was developed as part of the research project *Mobile - Interactive Musical Processes*, supported by FAPESP - São Paulo Research Foundation.

Mobile focuses its research on using and developing interactive processes in the creation of music mediated by the use of technology, taking into account the theoretical and conceptual aspects of interactive creation and investigation. The project also aims to exploring actions which encourage the interchange of ideas between a diversity of areas of knowledge.

Tábua Mobile was created as an instrument in which the areas of music, performance art, visual arts, luthiery and electronics were involved. In this first version, exploring interactivity and aspects of technological mediation were not priority; these explorations will be very important in new versions of the instrument, as well as involvement with lighting and computer programming areas.

The instrument was developed by Henrique Iwao & Marcelo Muniz, with the aid of Borys Duque - in charge of the wooden structure designing and construction, plus the painting job. It was initally build to be played in the first scene - *Cena 0*, coordinated by Henrique Iwao, with the authors plus Vitor Kisil as performers - of the multimedia collaborative work *Por Trás das Coisas*, directed by Fernando Iazzetta. This spectacle, presented at the opening of the New Media Art

International Conference & 4rt Upgrade! International Meeting: *SOFTBORDERS*, in 18th and 19th october 2010, UNESP theatre, was part of *Mobile*'s project initiatives. After this two day premiere, the authors started playing the instrument, as a duo, having performed at Estação Ciência Theatre, 18th november, part of the performance *O Rio, O Poeta e a* Cidade; at Villa-Lobos Institute, IV UNIRIO Composition Forum, 10th december; at Plano-B, 11th december, with guests Marcos Campello & Aquiles Guimarães; at Ibrasotope, 18th december (all performances in 2010).

2. Antecedents

A brief history of the antecedents to *Tabua Mobile*'s project can be made in respect to Henrique Iwao's artistic motivations, influences and his research on improvisation and the use of objects.

A music/composition student at UNICAMP - State University of Campinas (2001-2006), Henrique Iwao started playing improvised music, first at the piano, in 2002, latter including keyboard and electronics, from 2005 on. From 2004 to 2008 he played together with two colleagues from the university, Lucas Araújo (electric bass) & Mário Del Nunzio (electric guitar), in a group called *Trio Marco04*. In this group, some aesthetic positions started to develop, which latter became very important to the artist:

- The importance of the performative aspect in music. Improvised music relies on choices and decisions made live by the musicians. The reception of this performative art focuses both on the performers actions and on the sounds produced, as it may be important to the audience to see the performer deciding to do something and making a choice, or not being able to decide what to play. This feature make specially suitable, when playing (improvised) music, to include non-sound producing (as regards to perception) actions as expressive musical material .
- Physicality as an important aspect of music making. Evoking Barthes (1977, p. 188): "The 'grain' of the voice is the body in the voice as it sings, the hand as it writes, the limb as it performs." From this assumption, the relation between body, instrumental set and sound should be stressed, leading to questions such as: "how does the body leaves traces in the sound", and latter expanding this idea to "how does the objects used to produce sound leave traces of their shapes and weight on the sounds produced".
- The use of gesture as main element of musical articulation/composition. This implied developing a collection of possible actions whose musical identity is well established, and giving priority to notions of direction, movement and energy in the musical discourse.

Amplified sounds from everyday life and performative/theatrical actions were subject of many musical works, including those contained in *Song Books (Solos for Voice 3–92)* (1970) by John Cage, which became known to Iwao during his university years. In spite of not directly afecting his output in those years, from 2008 onwards, some concerns, related to that set of works, had a prominent role in helping to shape the ideas regarding improvisation and the use of objects:

- Applying the concept of non-intention to the production of sound, implying that sound could be a byproduct of some other action. That also meant that it was possible to establish different levels of intentionality as to the production of sound, and to use that as a musical parameter. From performing an action whose intention does not imply producing sound (in which sound is residual), to performing a musical gesture, whose intention is to produce a specific set of sounds.
- Amplification as a mean to make any sound musical. According to that view, in a musical context, making a sound sufficiently loud makes it part of the musical discourse. It also makes expressive tiny and (above other circumstances) almost inaudible sounds, which

require almost no movement and energy to be produced, on the part of the performer (electronic devices played turning knobs included in this category).

- The importance of stablishing a well defined performance space. In *Solo for Voice 23* (Cage, 1970), a chess game has its board amplified, making the sounds resulting from the movement of the pieces loud and expressive. The fact that the performance focus intensely on movements within the board builds and interesting relation with the board surroundings (the players - their chairs and posture, the pieces outside the board, etc).

From 2008 to 2010, the author worked for the brazilian artist Pan&Tone (Cristiano Rosa), as a producer for his workshops (2008-2010), in São Paulo. This workshops focused on teaching "circuit bending", a term coined by Ghazala (2005) to refer to a technique involving creative modification and misuse of electronic sound devices to create experimental music instruments. This led to a increasing interest in the use of self-made or self-customized electronics.

At that time, the experimental music duo N-1, from São Paulo, was already playing concerts using an assortment of heterogeneous objects: electronic devices, laptops, video cameras, toys, musical instruments, broken machines, turntables, etc. Their sound work, however, was based on the creation of loops and continuous textures, and on the juxtaposition of several sound layers, whereas what was sought by the author was to avoid such features.

By 7th august 2009, Henrique Iwao had to play an improvisation solo at the experimental music venue "Plano-B", in Rio de Janeiro. His choice of instrumental set combined piezoelectric sensors, circuit bended toys and oscillators, mini-amp,desk objects, laptop, volume pedals, a snare-drum, pocketknife, combs, aluminium paper and whatever small object available. Since one of the main ideas of this show was to perform fast movements involving many elements at once, it was decided that these elements would be put in a table, and their arrangement would be very important to the performer; he would constantly organize/disorganize the elements within this space.

Previously, in the same year, during the workshop at UNICAMP - "Improvisação Generativa com Novas Tecnologias", with Alexandros Markeas, from 27 to 31 july - there was a non serious improvisation session, when class was already dismissed. The workshop itself stressed notions of "sound object" creation/manipulation and gesture. Iwao's light joke was to take objects from the room, like pencils, chairs, chalkboards, scissors, old non-functioning speakers, erasers and use them on this session. Some days after this, using piezoelectric sensors to amplify the sounds and also circuit bended toys, Iwao played an improvisation concert at Ibrasotope - [ibe18] 1st of august -, together with Tim Vets and Valério Fiel da Costa.

The aforementioned solo was repeated two times, at the "VI Festival de Apartamento", Campinas, 26th september 2009 and at "Mini Circuito Azucrina Noise", Belo Horizonte, 2nd october 2009, using slightly different sets; furthermore, the same instrumental concept was used in other improvisation concerts. However, this use of amplification was not efficient and the sensors used would eventually malfunction due to exposure. The need to build a table with an already inner amplification system, instead of manipulating sensors above it led to the construction of the *Mesa Amplificada* ("Amplified Table") instrument, by Henrique Iwao, october 2009. The instrument is comprised of a wooden board with contact microphones glued on the lower side of it. After that, an extended version, with the addition of bolts, nails, holes, scratches and a small glued candy box was completed by appril 2010.

Tábua Mobile then, is part of a family of instruments, an ongoing research. It also incorporates two other types of sensors. The use of guitar pickups was inspired by clavichordist Oscar Jan Hoogland amplification system. In a performance by his group EKE, he would play his cracklebox without plugging it, due to electromagnetic induction.

Electrect microphones, on the other hand, were planned to be used, but the amount of gain required for good amplification levels caused feedback ostensibly. In an exploratory session, it was discovered by chance that this could be solved, when a box felt above the microphone and enabled mechanical coupling,which required lower gain levels.

3. Description of the Instrument

Tábua Mobile is comprised of a wooden structure equipped with sensors and an electrical system. It is played using several objects, which we shall call accessories. These will be described in Section 4.

3.1 Wooden structure

The wooden structure consists of a table with two plain boards, connected to four columns. The columns, painted white, size 4.5x4.5x90cm; they connect to the sides of the lower board, using two bolts each column. In each bottom part, there is a wheel, equipped with brakes, enabling the table to move easily when needed, while also to maintain stability when used for performance. In each upper part is a protrusion, enabling it to fit in the upper board slots.

The lower board, painted black, sizes 100x60x1.8cm and stands 35cm above the ground. It has eight 4.5x4.5x8cm additional wooden blocks, two in each corner, enabling connection with the columns. Its surface supports the electrical system (two black boxes placed on both sides of it), plus a mixer (placed in between the boxes). When they are not being used, *Tábua Mobile*'s accessories are put on the lower board, directly on its surface or on the black boxes and mixer.

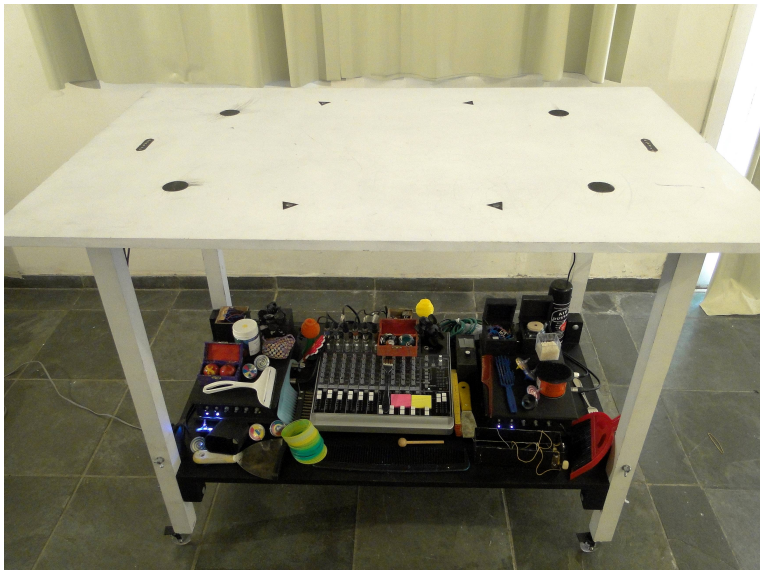

Figure 1. *Tábua Mobile.*

The upper board sizes 130x80x1.8cm. It is equipped with three type of sensors: four piezoelectric sensors are glued with liquid epoxy resin on the bottom surface, 25x19.5cm from each corner; four electrect microphones are inlayed at 45x12.2cm from each corner; two guitar pickups are also inlayed at 12.5x40cm from the bottom left and upper right corner, respectively. These inlays are done as to align the sensors with the upper board surface.

The upper board bottom surface is painted black and has four slots (simmetrically at 9.5cm from each corner). These make possible to mount the board on top of the columns at 95cm high. From the sensors audio cables connect to eight p2 outputs (four for the electrect microphones, two for the guitar pickups and two for the two pairs of contact microphones - left and right), four near the bottom left corner, between the guitar pickup and the respective column, and four near the upper right corner on each side, simmetrically.

The upper board upper surface is painted white, exception made to the spots corresponding to the electrect microphones and piezoelectric sensors positions, the first having black triangles painted around the microphones and the second having black circles painted (slightly larger than the actual sensors size).

3.2 Electrical system

As described, the sensors are placed simmetrically in the instrument upper board. Two electrical modules for power supplying, pre-amplification and impedance matching were build, containing each one a circuit for supplying power to the electrect microphones and a mixer circuit. In one of the modules there is a 110-12V transformer that supplies electrical power to both modules (it is connected to a wall socket). These modules are placed on each side of the lower board, with the main mixer between them. Each of them connects with three outputs (from the upper board), corresponding to two electrect and one guitar pickup sensors. Piezoelectric sensors are connected directly to the main mixer, as their signal amplitude is high enough to excite directly the mixer's inputs.

Electrect microphones receive their power supply and are then mixed together with the guitar pickup, resulting in only one output for each module, to connect to one of the mixer's inputs. The mixer circuit is based on an operational amplifier using the TL071 IC, working in two stages. In the first, an adder circuit is used, with a separate gain control for each of the three inputs and a on/off switch for each electrect input. In the second, the necessary gain to the excite the mixer input is provided, and the three inputs are mixed. Impedance matching is guaranteed due to the circuit's low impedance input and high impedance output. In the main mixer, the input corresponding to the left side of the instrument is panned left, and the correponding to the right side is panned right.

4. Description of the instrument's accessories

4.1 Objects

Several everyday items are used as accessories when playing *Tábua Mobile*. Actions with these objects include to: throw, catch, scratch, collide, rub, arrange, organize, desorganize, spread, pick, handle, deliver, look, gaze, combine, pile, destroy, caress tap and ordinary daily life usages.

So far, items used include: beer cans, bottle-caps, box of matches, candy boxes and candy boxes' lids, cell phone, chalk, combs (several types and colors), computer leftovers, compressed air spray, domino box and pieces, dried plants, flashlight (with dimmer), forks, glasses, goblets, grains (rice), hoops, japanese decorative stones, kalimba, knifes, lighter, magnets, matches, meditation chimes, meditation balls, pencil, pine cones, plastic animals toys, plastic jumping springs, pocketknife, sandpaper, screwdriver, squeegees, snare-drum, spatulas, spinning tops, spinning flashing balls, spoons, stick notes, umbrella.

Some of these are painted to best fit a specific performance visual identity, as happened in the instrument premiere, when items were painted black.

4.2 Electronic devices and boxes

Guitar pickups make possible interaction with electronic devices through eletromagnetic induction. Instead of having their audio outputs connected to loudspeakers, most of these devices, mounted on boxes (small enough to be manipulated by hand), connect to small coils inside them. As the intensity of eletromagnetic field is inversely proportional to the square of the distance from the source, by making the devices nearer or farther, amplitude crescendo and diminuendo gestures are enabled. The use of coils allows these devices to be perfectly silent when far enough from the guitar pickups. Some of the devices build are described hereunder:

- Sinusoidal oscillator: build using a IC NE555 in the astable multivibrator configuration, and modifying its output so as to approximate a sinusoidal wave. A LDR was added in parallel with the tension divider allowing frequency variation by corresponding variation in light incident intensity. A potentiometer controls the circuit minimun frequency. The device is mounted on a box that, when opened, exposes the LDR. The device is used together with a light diffuser, using a high luminance LED coupled to a crackled glass sphere.

- Square wave generator: using the same circuit as the sinusoidal oscillator, with same configuration. A potentiometer controls the wave frequency (from 4 to 200Hz). Its IC output is connected to a transistor amplifier circuit. It also incorporates a reed switch which allows to turn it on or off while interacting with magnetic fields.
- Hand controlled circuit bended double amplifier: two amplifiers, using the LM386 IC are interconnected: the first amplifier output goes to the second input, the second input goes to the coil. It is mounted on a box with an open side, in which the printed circuit board is disclosed. It is played by touching this printed circuit board surface with the hands. The resulting variations on resistance and connections within the circuitry produce fluctuations and transients, which feedback the system and are amplified, generating a variety of noises (from pulse to white noise sonorities).
- White noise generator: based on amplification of thermic noise from a general purpose transistor's junction. Two transistorized amplification stages are applyed. The device contains a low pass filter, triggered by a switch. This output is sent to a TDA2002 IC amplifier, connected to a small loudspeaker. The device is mounted on a metallic sphere, with the loudspeaker turned to an opening on the sphere. Differently from the previous three devices, the white noise generator can be used with the two other types of sensors for amplification, but with less efficiency.

Electrect microphones, as used in the instrument, have more efficiency when in direct contact with resonant bodies, and are mainly used via mechanical coupling, placing boxes with various materials directly above the microphones. Simple devices, using metal or wooden were built for these kind of interaction.

- *Gemido da Véia*: a rectangular metal box with a guitar string stretched to a tuning machine. Cotton lines are tied to the string, and are played by friction, using a moistened tissue, in a way similarly as when playing a cuíca. The metal box acts as a resonator.
- Closed cube: small wooden box with metallic objects in its interior, like nails or bolts. It is played through interaction with magnets, making the metallic objects collide with themselves and the cube's walls, producing sound.
- Box with nails: closed wooden boxes with nails on its top surface. Metallic objects are put into friction with the nails, producing sharp cutting sounds.
- Box with rubber bands: rubber bands are stretched upon open wooden boxes and are played similarly as a string instrument. These boxes are also used, sometimes simultaneously, for the manipulation of small objects in its interior, such as bottle-caps and small stones (or food grains).
- Alarm circuits: two small devices normally used as residential electronic alarms are mounted on a box with two drawers. They generate high frequency modulated in amplitude by a low frequency. They are triggered by the interaction of a magnet and a reed switch (which is automatically done when the drawers are pulled out). This system contains critical points which bring instability as to the sounds produced. The signal output is connected to piezoelectric transducers.

5. Discussion

Tábua Mobile was designed as an extended instrument, so that the performances using it involve a concern with visual elements and with the theatrical relations established between the performers, the objects and the instrument itself. This extension is viewed from the point of music making: as extending music itself to include performative art gestures, concerns from the visual arts, and a constant desire to stablish bonds with elements from daily life. In that sense the

performances involving *Tábua Mobile* and its development as an instrument continue experimental music practices, extant since the 1950s and 1960s (as reported in LaBelle, 2007).

In Section 2, some notions regarding music, improvisation and performance were introduced. These are here readressed in relation to *Tábua Mobile* and performances involving it:

- The importance of stablishing a well defined performance space. The focus of performative action is on gestures within the upper, white board space. This stablishes an "inside/outside" interesting relation: actions involving the upper board surroundings or the lower board are normally considered preparatory. This can be reinforced or attenuated. In addition, *Tábua Mobile*'s size makes possible that 2 persons play it at the same time, one each side, suggesting an opposition typical of board games.
- Amplification as a mean to make any sound musical. Through different types of amplification, everyday objects are recontextualized as sound producing musical accessories and black boxes as electronic music devices.
- The importance of the performative aspect in music. Several non-sounding actions are included as repertoire for performances with the instrument, such as: rearranging accessories positions on the upper board, using an object with its original daily life function (or similar), moving around the instrument, purposefully staying still, etc. These can be done as simple actions or with some degree of theatrical interpretation or stylization. This theatrical or stylization can also be used while performing actions which involve sound production.
- Intentionality as to sound production as a musical parameter. Moving accessories from and to the upper board and rearranging them within its space are actions in which there can be several levels of intentionality as whether this should make or not sound as a byproduct (or as a secondary goal). At high gain levels (specially as regards to the piezoelectric sensors), keeping this action silent is almost impossible. Some of the instrument's sensors can be turned off during performance, adding the possibility of muting (or almost) some action whose intention is to produce a specific sound.
- Physicality as an important aspect of musical performance. The objects are scratched, dragged, tossed and thrown on the upper board. The instrument is robust enough to endure hits and collisions, and its size demands large movements and gestures. The contact microphones (piezoelectric sensors) are panned as to create a stereo field related as to where the 'sounding gesture' was made in the upper board.
- Gesture as a main element of musical articulation. Gesture can articulate the above mentioned actions. Physical gestures can correspond or not to musical gestures, with or without sound as a main element.

The everyday items and objects used as accessories are recontextualized as sound producing/performative/aesthetic objects - mainly by the fact that they are dislocated from their usual context (kitchen, workshop, personal use, meditation, feeding, desk office, traditional music, childrens parties and toys, games) to an artistic performative space, and dealt with in artistic performances. This dislocation strategy aims to integrate daily life and artistic expression.

From using these objects in unusual ways to using them in usual ways (but out of the usual context) there are several transition levels that can be addressed in performance. Items can be chosen due to a combination of several aspects: the set of sounds and specific sonorities it can produce; the specific performative gestures it enables; its visual appealingness; the performers willingness to attempt renewing the objects meaning and thus its usefulness; and the set of references the object brings into play when used. There is a tendency to use "what is available", trying to extract some expressiviness out of the object after having chosen it for a performance.

Through improvisations (free or oriented by some set of rules) with the different possible elements involving *Tábua Mobile*, a mapping of the possibilities, combinations and specificities of the instrument is being done. This is an ongoing research.

6. Future Implementations

A request for support was sent to FAPESP in order to continue the *Tábua Mobile* project in 2011-2012 and to implement its 2.0 version. If approved, the instrument will be improved and expanded. The research on how to include and integrate visual and theatrical elements during the performances with the instrument will be intensified; the mapping of the possibilities offered by and the specificities of the instrument will continue.

Future implementations consist of:

- Two video cameras, positioned above the instrument. The images captured will be projected (with or without visual effects and manipulation) to the audience usign a video projector; these images will provide data to be used in a pattern recognition software, in order to trigger certain effects and filters to the sounds produced by the instrument.
- Lighting system, controlled by the performers through the use of pedals. This aims to expand the instrumentality of the performers to include light operation (controled by using their feet), without affecting the manipulation of the objects (by their hands). This system will include light spots, color customization possibilities, LEDs, strobes, dark light and dimmers.

7. Acknowledgements

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