Composition Models for Augmented Instruments: HASGS as Case Study

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ABSTRACT

This paper presents the concept of HASGS regarding the augmentation procedures applied to an acoustic instrument, at the same time that it is analyzed how composers applied technology prototyped to the composition of works. The development of HASGS has been driven by the compositional aspects of the original music created for this specific electronic augmented instrumental system. Instruments are characterized not only by their sound and acoustical properties but also by their performative interface and evolutionary repertoire. This last aspect has the potential to establish a practice among performers at the same time as creating the ideal of community contributing to the past, present and future of that instrument. Augmenting an acoustic instrument places some limitations on the designer´s palette of feasible gestures because of those intrinsic performance gestures, and the existing mechanical interface, which have been developed over years, sometimes, centuries of acoustic practice. We conclude that acoustic instruments and digital technology, are able to influence and interact mutually creating Augmented Musical Performance environments based on the aesthetics of the repertoire being developed. This work is, as well, a resource of compositional methods to composers and programmers.

Author Keywords

Augmented Instruments, Saxophone, Gestural Interaction, Live Electronics

1. INTRODUCTION

Augmenting an acoustic instrument places some limitations on the designer´s palette of feasible gestures because of those intrinsic performance gestures, and the existing mechanical interface, which have been developed over years, sometimes, centuries of acoustic practice [9]. A fundamental question when augmenting an instrument is whether it should be playable in the existing way: to what degree, if any, will augmentation modify traditional techniques? The goal here, according to our definition of "augmented", is to expand the gestural palette, at the same time as providing the performer with extra control of electronic parameters. From previous studies conducted by this research team we can say that the use of nonstandard performance gestures can also be exploited for augmentation and is, thus, a form of technique overloading.

It seems straightforward to define musical gesture as an action pattern that produces music, is encoded in music, or is made in response to music. The notion of gesture goes beyond this purely physical aspect in that it involves an action as a movement unit, or a chunk, which may be planned, goal directed, and perceived as a holistic entity [3]. Movements used to control sound in many multimedia settings differ from those used for acoustic instruments. For digital electronic instruments the link between gesture and sound is defined by the electronic design and the programming. This opens up many possible choices for the relationship between gesture and sound, usually referred to as mapping. The mapping from gesture to sound can be fairly straightforward so that, for example, a fast movement has a direct correspondence in the attack time or loudness of the sound. However, with electronically generated sounds it is also possible to make incongruent, "unrealistic" links between gesture and sound. The gestural control of electronic instruments encompasses a wide range of approaches and types of works, e.g. modifying acoustic instruments for mixed acoustic/electronic music, public interactive installations, and performances where a dancer interacts with a sound environment. For these types of performances and interactions, the boundaries between, for instance, control and communicative gestures tend to get blurred. In the case of digital interactive performances, such as when a dancer is controlling the sound produced, there is very little distinction between sound-producing gestures, gestures made, or accompanying movements. To give enough freedom to the performers, the design of the interaction between sound and gesture is generally not as deterministic as in performances of acoustic music. In our perspective, augmented instruments and systems should preserve, as much as possible, the technique that experienced musicians gain along several years of studying the acoustic instrument. The problem with augmented instruments is that they require, most of times, a new learning process of playing the instrument, some of them with a complex learning curve. Our system is prototyped in a perspective of retaining the quality of the performance practice gained over years of studying and practicing the acoustic instrument. Considering, for example, the electric guitar one of the most successful examples of instruments augmentations and, at the same time, one of the first instruments to be augmented, we consider that the preservation of the playing interface was a key factor of success, allied to the necessity of exploring new sonic possibilities for new genres of music aesthetics. The same principles are applied to synthesizers as the Moog or the Buchla's Keyboards from the 70's, that stills influence new instruments, both physical instruments and digital applications. With HASGS is our intention to integrate the control of electronic parameters organically providing a degree of augmented playability within the acoustic instrument.

2. PROTOTYPING

HASGS was initially developed having in mind to solve performative issues regarding pieces using external controllers as footswitches or pedals, as well as other external software controllers. It is the repertoire that has been influencing the way this system has been developing. In this scenario, we mention the concept of Reduced Augmentation because, from the idea of having all the features of an EWI (Electronic Wind Instrument) on an acoustic instrument, which could lead to performance technique overload or, as well, making the acoustic instrument too much personal in terms of electronical hardware displacement. The proliferation regarding to the creation of augmented instruments in the NIME context is very big, but just a little number of them acquire recognition from the music market and players. As any musical instrument is a product of a technology of its time, augmented instruments are lacking the validation from composers and performers apart from their inventors. Due mostly to the novelty of the technology, experimental hyper-instruments are mainly built by artists with a composer/performer background [2]. These artists mostly use the instruments themselves. There is no standardized hyperinstrument yet for which a composer could write. It is difficult to draw the line between the composer and the performer while using such systems. The majority of performers using such instruments are concerned with improvisation, as a way of making musical expression as free as possible [7]. Augmented performance can be considered enactive knowledge. The term enactive knowledge refers to knowledge that can only be acquired and manifested through action. Examples of human activities that heavily rely on enactive knowledge include dance, painting, sports, and performing music.

The first prototype of HASGS, we were using attached to the saxophone, one Arduino Nano board, processing and mapping the information from one ribbon sensor, one keypad, one trigger button and two pressure sensors. One of the pressure sensors was located on the saxophone mouthpiece, in order to sense the teeth pressure when blowing. Most of the sensors (ribbon, trigger, pressure) were distributed between the two thumb fingers. This proved to be very efficient once that the saxophonist don't use very much these fingers in order to play the acoustic saxophone. This allowed, as well, very precise control of the parameters assigned to the sensors. The communication between the Arduino and the computer was programmed through Serial Port using USB protocol. This communication sent all the MIDI commands. The computer was running a Node.js program that simulated a MIDI port and every time it received data from the USB port, it sent that data to the virtual MIDI port.

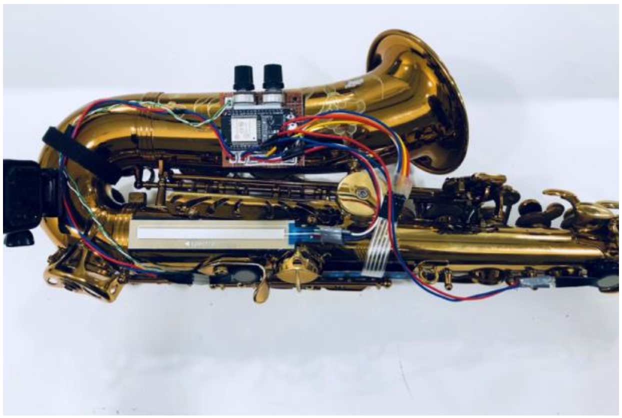

Figure 1. HASGS Version 3.

Taking in consideration that this system has an evolutionary perspective, version 3 started with the substitution of the Arduino Nano by an ESP8266 board. The communication between the sensors and the data received into the computer became wireless due to this fact. Both the computer and HASGS connect to a Personal Hotspot created by a mobile phone API. This specification will allow much performance freedom to the performer, allowing now space for the integration of an accelerometer/gyroscope. At this stage were added to the system, two extra knobs, allowing independent volume control, mainly useful for gain and volume control.

At this stage of the research, and after several performance opportunities and prototypes, we decided to include more capabilities as seen in the following figures and start to use an ESP32 board providing Bluetooth Low Energy and Wifi connectivity as well as the main microcontroller for the system. This last version includes: up/down selectors, 2.5 axis joystick, piezo sensor, connection selector, accelerometer/gyroscope, extra trigger switches and several status led indicators for multiple purposes.

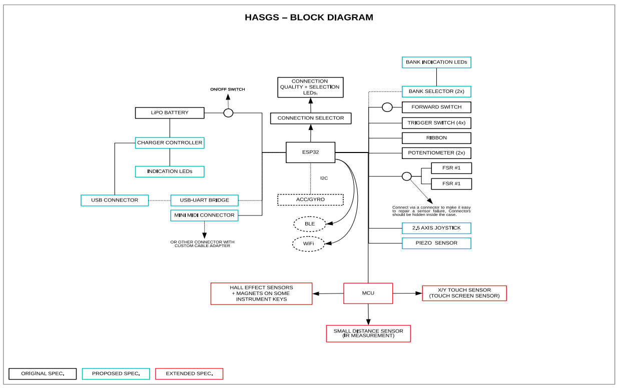

Figure 2. HASGS Block Diagram.

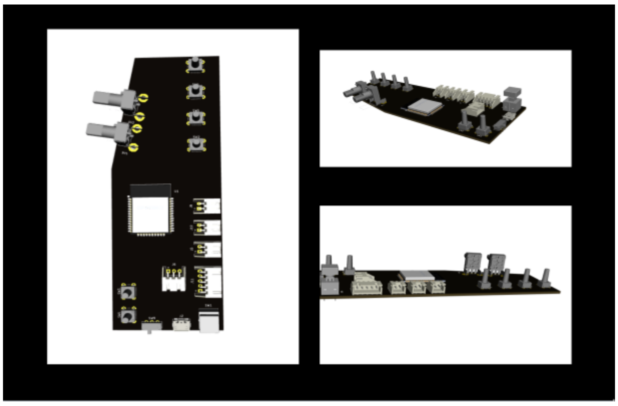

Figure 3. HASGS Board Final Version.

The manipulation of HASGS is directly associated with gestural controls. Movements used to control sound in many multimedia settings differ from those used for acoustic instruments. For digital electronic instruments the link between gesture and sound is defined by the electronic design and the programming. This opens up many possible choices for the relationship between gesture and sound, usually referred to as mapping. The mapping from gesture to sound can be fairly straightforward so that, for example, a fast movement has a direct correspondence in the attack time or loudness of the sound. However, with electronically generated sounds it is also possible to make incongruent, “unrealistic” links between gesture and sound. The gestural control of electronic instruments encompasses a wide range of approaches and types of works, e.g. modifying acoustic instruments for mixed acoustic/electronics music, public interactive installations, and performances where a dancer interacts with a sound environment. For these types of performances and interactions, the boundaries between, for instance, control and communicative gestures tend to get blurred. To give enough freedom to the performers, the design of the interaction between sound and gesture is generally not as deterministic as in performances of acoustic music.

3. SOFTWARE

3.1 Mapping

In the process of developing repertoire in order to create an erudite community around HASGS, a table of instructions was sent to composers, regarding the communication between sensors and the computer/software. We suggested a normalization on the software used, giving preference to Max/MSP. A Max/MSP Abstraction was produced with the purpose of providing mapping instructions and options to composers. Was our intention to provide a rewarding experience when programing/composing for this augmented instrument, even to less experienced composers in the domain of programing live electronics. This Abstraction refers to the third version of the prototype, once the pieces analyzed here were written for HASGS version 3.

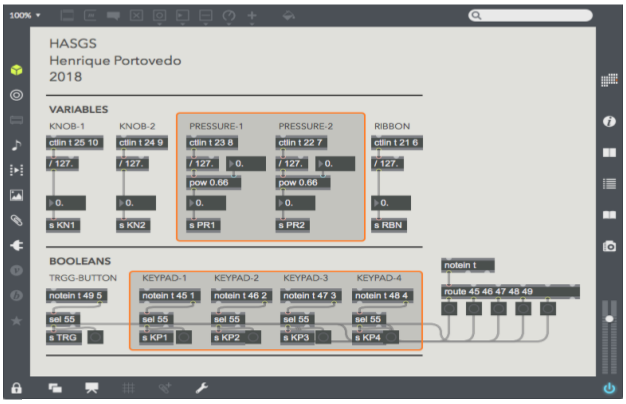

Figure 4. HASGS Mapping Abstraction

In the scope of this work, and for detailed information, we refer to the different sensors as:

Knob 1 (Potentiometer): KN1
Knob 2 (Potentiometer): KN2
Pressure Sensor 1 (Left Thumb Finger): PR1
Pressure Sensor 2 (Right Thumb Finger): PR2
Ribbon Sensor: RBN
Keypad 1: kp1
Keypad 2: kp2
Keypad 3: kp3
Keypad 4: kp4
Trigger Button: TRG

3.2 GUI

Each piece has been developed with different GUI. Initially we had the intention to uniform all the visual interfaces of the pieces. This could be interesting for other performers when approaching HASGS and its "language". In other hand we understood that each piece requires different GUI, once they have completely different concepts of using the augmentation system. This fact has proven that diversity is probably the richest argument of HASGS regarding its use on different composition models. These pieces resulted in different ways of using the saxophone's sonic materials, for this reason, it's not surprising that the visual interface of each piece has different configurations and characteristics. The evolution on notation systems and on visual programming has contributed largely for the development of extended techniques and instrumental virtuosity. Yet when acoustic instruments are played or combined in unconventional ways, the result can sometimes sound like electronic music [8]. One of the things to be considered, regarding to the new repertoire for augmented instruments, and more precisely, to this augmented saxophone system, is the presence of multiple layers of information, something that still not common when writing for a monophonic instrument. This shows, as well, a different approach of programing GUIs when comparing visual interfaces of traditional electroacoustic pieces with pieces for an augmented system.

The goal of user interface design is to make the user's interaction as simple and efficient as possible, in terms of accomplishing user goals. Good user interface design facilitates finishing the task at hand without drawing unnecessary attention to itself. Graphic design and typography are utilized to support its usability, influencing how the user performs certain interactions and improving the aesthetic appeal of the design; design aesthetics may enhance or detract from the ability of users to use the functions of the interface [6]. According to the ISO 9241 standard for the organization of information (arrangement, alignment, grouping, labels, location), for the display of graphical objects, and for the coding of information (abbreviation, color, size, shape, visual cues) by distinguished in seven attributes: Clarity, the information content is conveyed quickly and accurately; Discriminability, the displayed information can be distinguished accurately; Conciseness, users are not overloaded with extraneous information; Consistency: a unique design, conformity with user's expectation; Detectability: the user's attention is directed towards information required; Legibility, information is easy to read; Comprehensibility, the meaning is clearly understandable, unambiguous, interpretable, and recognizable. Artists and scientists have a perpetual interest in the relationship between music and art. As technology has progresses, so too have the tools that allow the practical exploration of this relationship. Today, artists in many disparate fields occupy themselves with producing animated visual art that is correlated with music [1].

4. REPERTOIRE

4.1 Cicadas Memories

CICADAS MEMORIES is much more an improvisational process than a piece of written music. The fact of the piece being composed for an augmented instrument is important regarding the type of values produced by those sensors: modulating variables vs boolean values, continuous stream of data vs fixed values, relative freedom of the player's body and gestures vs necessity to interact with the sensors from the hands and fingers, etc. This means that the player's gestural activity on the sensors conditions the way he performs on his instrument, thought as a conventional tenor saxophone: the sensors playability modifies the saxophone playability in terms of access to the key, in a conventional way of playing. It became an evidence that the 4 pads could be thought as a « 4 bits data flow generator ». Since 4 bits means different 16 values (ranging from 0 to 15), it quickly became clear that those 16 values were like historically related to the traditional sixteenth note of the 4/4 bar in western music. The method eventually introduces a non standard musical way of thinking : the present of the live performed music is (at last partially) controlled, altered by the actualization of the past. In the case of CICADAS MEMORIES, this means that the actual gesture of the player will alter (one minute later) the electronic sound-field used as the sonic background for the saxophone's rhythmic patterns (also created by the keypad's « 4 bits » layers of memory). Therefore, the performer has to develop two simultaneous ways of thinking (and acting) while performing : a part of his mind for the present (the patterns imposed by the software but created by the player's past action on the keypads), another one for the future (its gestural connection to the sensors). He has to deal with two temporalities usually separated in the act of live music performance: he writes the future score and improvises on his past gestures, in the present time.

4.1.1 Controls per synth

The control values of all sensors were normalized from 0 to 1 data values. The abbreviation nm stands for normalized.

4.1.1.1 [p+delay] synth:

(pr1nm/kn2nm): delay time
(pr2nm/rbn2nm): delay feedback
(kn1nm/kn2nm): delay resonance
(pr2nm/kn1nm): overdrive 1 gain
(pr1nm/kn2nm): overdrive 2 gain
(pr1nm/kn2nm): synth output gain

4.1.1.2 [p all-sqnz] synth:

kn1nm: synth output gain
kn1nm: right channel delay in samples (stereo width)

NV1: connected to KP1 inside the [p distrib] sub-patch, it increments the tab note-value to adjust the allpass filters time (note values converted to ms) each time the *binary* combination of the Keypad 1 is equal to 0 or 8
NV2 : Keypad 2 binary combination equal to 1 or 4
NV3 : Keypad 3 binary combination equal to 2
NV4 : Keypad 3 binary combination equal to 4

S1 to S16 activates each step of the sequencer via the Keypads (4 steps / sixteenth notes for each PAD in relationship with the display in the main patch) TRG resets all sequencer's steps to 0

[r seq_step] adjusts the number of steps (sixteenth notes, from 1 to 16) of the sequencer in relationship with the *binary* combinations (inside the [p distrib] sub-patch). This function might appear complex and requires some time using the Keypads only :
KP1 has a value equal to 8
KP2 has a value equal to 4
KP3 has a value equal to 2
KP4 has a value equal to 1

The different *binary* combinations of the Keypads values can produce every possible loop length from 1/16 to 16/16. Of course, only the steps (orange squares are active steps) included in the loop length will be played.

4.1.1.3 [p glitch-synth] synth:

cnt1 to cnt16 (in relationship with the *binary* combinations of the Keypads) control some synced frequencies defining the gain of the incoming signals in the filters as well as the two samples length, start and end points, speed / pitch in regard to the tempo so, in sync with [p all-synth] and [p rain-osc] patches.

KP1 sets the center frequency of the resonant filters in a random way
pr1nm sets the output gain for each sampler
kn1nm adds some kind of saturation to the signal (left sampler)
kn2nm adds some kind of saturation to the signal (right sampler)

4.1.1.4 [p rain-osc] synth:

(pr1nm/pr2nm): synth output gain
kn1nm: range of the random starting frequency (left) of the glissando
kn2nm: range of the random starting frequency (right) of the glissando
pr1nm: added value to the starting frequency (left) of the glissando
pr2nm: added value to the starting frequency (right) of the glissando
rbn1nm: added value to define the ending frequency of both glissandi (left and right have different values even if they share the same controller)
kn1nm: attack filtering / smoothing (left)
kn2nm: attack filtering / smoothing (right)
(pr1nm/pr2nm): allpass filters gain

4.2 Comprovisador

Comprovisação nº 9 was a musical performance made of one soloist who uses an augmented saxophone (HASGS), an ensemble of musicians who sight-read an animated staff-based score and a real-time composition and notation system (Comprovisador) operated by both soloist and performance director/mediator.The performance aims to create a context where both composed and improvised elements coexist in aesthetically relevant interdependency, taking advantage of the possible synergies between a real-time composition and notation system and a hybrid acoustic-control augmented instrument to enhance the level of interactivity. The interaction flow is completed by the soloist's reaction to the composed response and further ramified by the presence of a performance mediator, establishing a complex dialectical relationship.

Comprovisador is a system designed by Pedro Louzeiro to enable mediated soloist-ensemble interaction using machine listening, algorithmic compositional procedures and dynamic notation, in a networked environment. As a soloist improvises, Comprovisador's algorithms produce a staff-based score in real-time that is immediately sight-read by an ensemble of musicians, creating a coordinated response to the improvisation. Interaction is mediated by a performance director through parameter manipulation. Implementation of this system requires a network of computers in order to display notation (separate parts) to each of the musicians playing in the ensemble. More so, wireless connectivity enables computers – and therefore musicians – to be far apart from each other, enabling space as a compositional element. A host computer centralizes algorithmic tasks accepting pitch input from the soloist and parametric input from the mediator – and, in this special case, from the soloist as well.
In the present *Comprovisação*, HASGS was used as a musical interface with dual purpose:

1) to feed Comprovisador's algorithms with improvised musical material (via acoustic instrument)
2) to control several of its parameters (via controllers and sensors) thus, claiming some of the performance director's mediation tasks for the benefit of interaction flow

A thoughtfully outlined performance plan is attained through presetting of algorithmic parameters and corresponding control mapping. Each preset yields different types of musical response, ranging from reactive synchronized tutti impacts to intricate micropolyphonic textures. HASGS keypad allows the soloist to navigate through Comprovisador's presets according to the plan and subject to his momentary desire, while other HASGS controllers (ribbon, trigger button, knobs, pressure and acceleration sensors) will enable him to control parameters such as dynamics, density (harmonic and instrumental), register and speed, among others. Furthermore, he's be able to trigger certain algorithmic actions and transformations including capturing melodic contours and recalling previous passages. These may include passages that were generated earlier during the performance as well as pre-composed (pre-rehearsed) ones.

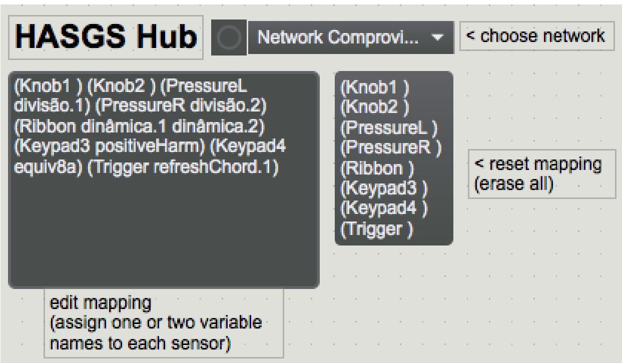

Figure 5. HASGS Hub in Comprovisador.

The aforementioned synergies enabled a higher degree of interactivity between improviser and sight-readers (which is to say, between improvisation and composed response) than was possible with Comprovisador alone. By empowering the soloist with control over selected parameters of either expressive or compositional/formal nature, more consequential interplay is expected. Moreover, the performance mediator is likely to be more aware of the macrostructure while in control of parameter mapping. On the other hand, the use of HASGS in a different environment from what it was designed for – in short, to perform pieces involving control of electronic sound devices – poses challenges and creates learning opportunities regarding performer experience, since interaction with such devices is of a more instantaneous kind than with composition algorithms, and even more so regarding real-time notation ones.

4.3 Indeciduous

This piece was heavily inspired by the sonic explorations of the duo Suicide. The title hints at the unrelenting nature of the piece and is an anagram for 'suicide' and 'sound'. The first performance of this piece was on March 19, 2018 at Karl Geiringer Hall of the University of California, Santa Barbara on a recital of combined support by the Corwin Chair Endowment and the Center for Research in Electronic Art Technology (CREATE).

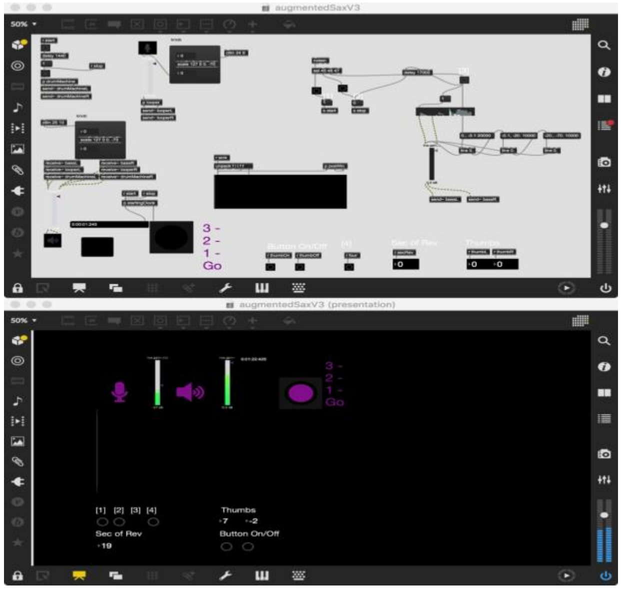

Figure 6. Indeciduous Patching/Presentation modes.

This piece is to be performed as a free blues over an unrelenting drum machine. Durations notated are a suggestion as are gestures/pitches, with the exception of the pitches accented with ❋, these notes are required and must be looped by the performer. Potentiometers on the HASGS control the sax gain (kn1) and the overall gain of the performance (kn2). The ribbon controller (rbn) controls the time of reverb measured in seconds. The thumb pressure sensors control the size of the looping window (pr1) and the location of that looping window (pr2). The keypad starts the drum machine (kp1), stops the drum machine (kp2), triggers events (kp3), and stops looping (kp4). The trigger button (trg) starts and stops recording into the looper.

5. Conclusions

Starting as an artistic exploratory project, the conception and development of the HASGS (Hybrid Augmented Saxophone of Gestural Symbiosis) became, as well, a research project including a group of composers and engineers. The project has been developed at Portuguese Catholic University, University of California Santa Barbara, ZKM Karlsruhe and McGill University Montreal. The idea to benefit of this augmentation system was to recover and recast pieces written for other systems using electronics that are already outdated. The system intended as well to retain the focus on the performance keeping gestures centralized into the habitual practice of the acoustic instrument, reducing the potential use of external devices as foot pedals, faders or knobs. Taking a reduced approach, the technology chosen to prototype HASGS was developed in order to serve the aesthetic intention of some of the pieces being written for it, avoiding the overload of solutions that could bring artefacts and superficial use of the augmentation processes which sometimes occur on augmented instruments prototyped for improvisational intentionality. We presented three pieces as case studies that make the use of such system in completely different ways and qualities. Traditional music instruments and digital technology, including new interfaces for music expression, are able to influence and interact mutually creating Augmented Performance environments. The new repertoire written by erudite composers and sound artists is contributing then for a system intended to survive in the proliferation of so much new instruments and interfaces for musical expression. The outcomes of the experience suggest as well that certain forms of continuous multi parametric mappings are beneficial to create new pieces of music, sound materials and performative environments. Future work include a profound reflection on the performative and notational aspects of each piece, evaluating the mapping strategies of each new piece that is being written for HASGS. The notational aspect of the pieces being created will be, as well, a key aspect of this research, and how it could contribute to new interpretative paradigms. In the scope of this paper we decide to focus on the aesthetic of each piece and how HASGS could serve as the interface of their musical intention, how to influence them and how the instrument be characterized in the new paradigm on instrumentality within the concept of assemblage.

6. ACKNOWLEDGMENTS

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8. Appendices

This evolutionary augmented instrument project is described at https://www.henriqueportovedo.com/hasgs/