

# Sonically Augmented Found Objects

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## ABSTRACT

We present our work with augmented everyday objects transformed into sound sources for music generation. The idea is to give voice to objects through technology. More specifically, the paradigm of the birth of musical instruments as a sonification of objects used in domestic or work everyday environments is here considered and transposed into the technologically augmented scenarios of our contemporary world.

## Keywords

Rag-time washboard, sounding objects, physics-based sound synthesis, interactivity, sonification, augmented everyday objects.

## 1. INTRODUCTION

Usually, in electronic music and performance, the sound material is somehow an *a priori*: it results from some synthesis method or some processing technique applied to a selection of samples. Interface invention and design in the context of *Sound and Music Computing* (SMC) start from music and face, as main issue, the achievement of an appropriate interface/instrument enabling users to control a specific sound material in a musical and expressive way. It could be said that, established a certain musical style and aesthetics, the problem is how to produce music in a consistent way through the manipulation of some physical system controlling computer-generated sound in an effective (expressive) way [1] [2].

In this work, we try to turn things up-side down: given some objects, we wonder how to provide them with an “expressive voice”. This voice will be the source of music. In other words, music as a consequence of a process that starts from the object and goes through the definition of a sound (the voice of the object) and ends in some form of organized sonic events that give birth to music.

In addition, these kind of processes involve a manipulation of the objects that somehow transmits expressivity to sound through gesture. The fact of using everyday objects, thus, can provide sounds with the richness of meaning and expressivity of everyday actions. Indeed the interaction with and manipulation of everyday

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object involves “natural” and well-known gestures, easy to be performed by the player and to be visually interpreted by listeners.

A third issue considered in this work is the practice of augmenting everyday objects with sonic features. This is for example what is envisaged in one of the three future scenarios depicted in the SMC Roadmap [3]: “[...] many sound devices will have a general purpose computer in them and will include quite a number of real-time interaction capabilities, sensors and wireless communication. Basically, any sound-producing device will be able to behave like a personalised musical instrument. Music making will become pervasive and many new forms of communication with sound and music will become available. Music content will be inherently multimodal and music making available to everyone: music from all to all.”

The paper has the following structure: in Section 2, the theme of everyday objects employed as musical instruments is introduced; Section 3 deals with embodiment and gesture in musical interfaces design; Section 4 concerns aspects related to physics-based *Sonic Interaction Design* (SID); in Section 5 we present our former work and summarize the issues coming out of the previous sections; in Section 6 examples of what we mean by *Sonically Augmented Found Objects* (SAFOs) are provided; in Section 7 conclusions are drawn.

## 2. EVERYDAY OBJECTS AND MUSIC

From the point of view of Ethnomusicology, the transformation of everyday objects into musical instruments is quite a common process: music raises from the employment of working-tools, domestic (e.g., kitchen) objects, natural product of human activities or natural objects tout-court [4]. Examples are drums obtained from clay vessels or from pumpkins, bones with notches scratched by a stick, shells used as trumpets, bamboos that become whistles, the musical arch and so on. Other examples are cross-cultural and well-known to everybody as a grass tightened between two fingers and used as a reed. This seems to respond to an impulse of humans to make things of our environment talking. A very good example (maybe even a paradigm) of what we mean by use of everyday objects is the washboard employed in the rag-time tradition: two different tools, a washing board and a set of five thimbles – washing and sewing activities together – employed for producing a sound able to act as a surrogate of a whole drum-set thanks to its natural usability.

In this perspective, the musical practice of “found objects” is very appealing and challenging. Initiated by experienced artists such as Marcel Duchamp, this kind of aesthetics focuses on the use of existing objects that have not been designed for artistic purposes. Found objects may exist either as utilitarian, manufactured items,

or things which occur in nature. In any case, the artist (e.g., the musician) exploits the potentialities of the objects as a vehicle of artistic meaning. These objects are denoted as “found” in order to distinguish them from other purposely created items used in arts. From the early compositions of *Musique Concrète* such as Pierre Henry’s *Variation pour une porte et un soupir* (1963), John Cage’s compositions, or astonishing soundtracks such as Jacques Tati’s movie *Playtime*, this practice continues investigating expressive qualities of everyday artifacts<sup>1</sup>, electronics included (see for instance [5] for the practice of circuit bending, and [6] for the notion of infra-instruments).

### 3. EMBODIED INTERFACES

Embodiment [7][8] is a fundamental issue of the musical practice. Generally speaking, embodiment is the result of a learning process resulting from perceiving by doing and doing by perceiving. The action-perception loop (the so-called *Enaction*<sup>2</sup>) model describes the usual modality of most of our actions. Indeed, a perceptually guided action is what a musician performs when playing an instrument. Somehow, traditional musical instruments can be seen as the means for transforming physical movements into musical sounds. In this sense, musical composition becomes an implicit process of organizing and directing physical human gestures on a musical instrument. In other words: music as sonification of gesture.

Nowadays, in a SMC scenario, embodiment is not a necessary feature. Movement is no longer limited to the physical actions required to play traditional acoustic and electro-acoustic instruments. A whole new range of musical “gestures” can be imagined and designed for new interfaces [9]. A physical gesture can affect music at different levels: possibly modifying the structure of the musical discourse (macro-level), or adjusting some parameters of sound synthesis or processing (micro-level). Also, new instruments can take any shape or size [10]. For instance, they could occupy a large space, or be split into individual parts forming a kind of network.

All of these points offer new and exciting perspectives for musical production [11]. However, it is well known that they involve also the risk of achieving (paradoxically) poor results. Disembodiment, weak mapping strategies, loss of expressive details are problems often faced in the design of new interfaces.

Ishii’s *Tangible User Interfaces* (TUIs) represent a fundamental innovation in the sense of recovering the body [12]. The idea is to employ physical objects and the surrounding space as a media bridging the gap between virtual and physical worlds. Since the early 1990s, the Hyperinstruments Group of the MIT Media Lab has developed a number of applications such as musical toys for children and other musical devices requiring no pre-existing traditional instrumental skills. One of the musical applications realized within the group are the *Squeezables* [13]. The possibility of controlling sound parameters by means of a physical effort appears as a successful strategy. Another example is given by *Tangible Acoustic Interfaces* (TAIs) [14]. The idea of using acoustical signals generated by mechanical interactions with objects as control signals has many benefits: in fact, the physical/gestural expressivity of the manipulation is transmitted

through in-solid acoustic waves; further, thanks to the analogy of these waves with sound, they can be “naturally” mapped to a perceptually clear and energetically consistent sound response. The limit – or the advantage – of TAIs with respect to TUIs is a restriction of the scope: from “no limit” in the physical design of the input interface, to “no limit” in the choice of any object as an input interface. The possibility of using “any object” offers the great opportunity to skip (to a certain extent) any training or practice stage: the “interaction → sound” mapping can be designed so that the sound responds in an effective way to usual/everyday interactions with the objects.

In the present work, we consider embodiment as a consequence of employing everyday objects. As in the case of TAIs, the fact that people can play the “instruments” by means of usual (everyday) and well-known gestures is exploited.

### 4. PHYSICALLY-BASED INTERACTION

The third aspect considered in this work is related to sound synthesis and control. The goal is to adopt sound synthesis algorithms allowing an effective control over the sound production. Sound is as a pressure signal generated by interactions with and between objects. By modeling sound sources in terms of their physical behavior it is possible to define a natural mapping between human gestures and the control parameters of the sound model, this way providing physical consistency between action and sound.

An example of physics-based sound models are those developed in the context of the SOb (*the Sounding Object*) [15] and the CLOSED<sup>3</sup> (*Closing the Loop Of Sound Evaluation and Design*) research projects. The SOb/CLOSED algorithms comply with the modular structure *resonator-interactor-resonator*, hence representing the interaction between two resonating objects. Thanks to the modularity of the framework adopted, it is possible to connect any couple of resonators through complex (non-linear) interaction models. The sound models were developed following the guideline given by the so-called ecological acoustics [16]. Simple sound events were modeled for instance as impacts, frictions, bubbles. These have been recognized as the basic sonic events underlying many complex processes. For example, rolling, bouncing and crumpling sounds are implemented by means of complex temporal patterns controlling the generation of elementary impact events; rubbing, squeaking and braking sounds can be traced back to frictions; finally, the bubble model is the basis for burbling, dripping, pouring and frying sounds. As a result of the physical consistence of the models, it is straightforward to map their control parameters to continuous physical interactions, and to describe resonators and interaction models by means of their physical and geometric properties.

This kind of approach is the one most largely adopted in SID: a novel discipline, emerged in the last decade from the fields of ecological acoustics, soundscape and everyday listening studies, and interaction design. In SID, the functional aspect of sound, that is its role as a “carrier of information”, plays a fundamental role. The goal of SID is to create or reveal new functionalities, to enhance the sonic identity of objects or to improve their usability and user performance during the interaction. Sonic information contributes, together with visual, tactile and haptic qualities, to forming the experience of an object. Moreover, when embedded

<sup>1</sup> For instance [http://www.youtube.com/watch?v=Z7h8qkMBE\\_E](http://www.youtube.com/watch?v=Z7h8qkMBE_E)

<sup>2</sup> <https://www.enactivenetwork.org/index.php?8/objectives>

<sup>3</sup> <http://closed.ircam.fr/>

sound and (inter-)action are tightly coupled, the kinesthetic and tactile experiences establish a strong perceptive link between sound feedback and the artifact-source. This happens to such an extent that we say that the sound *is* the thing.

All of these aspects are inherited from the authors' experience in the context of SID, and transposed into this new work. The goal is then to turn sonically interactive everyday artifacts into musical instruments by challenging the application of a solmization system to them. The aim is to give birth to a new generation of sonically augmented found objects [17] [18].

## 5. AUGMENTED TABLES

A conspicuous set of tangible interfaces and table-based interactive sonic devices have been developed during the last decade. Most of existing tabletop-like tangible interfaces, such as the *reactTable* [19] and other related devices, act as controllers of a sound synthesis and processing engine, focusing on and questioning about expression issues. Another example, the *Table Recorder*<sup>4</sup> is a sonically augmented table whose concept and realization cleverly couples interaction and real everyday sounding objects (such as glasses, cans, dishes and so on). The *Cardboard Box Garden* [20] explores everyday interaction with an augmented cardboard box as container of sounds; interaction with boxes allows to manipulate stored sounds in a simple and intuitive way. Of interest is also the *Tactophonics* [21], a design research in musical affordance by using sounds as control signals. In most of the cases these tangible interfaces serve as controls for complex sound processing, effects or sequencer-based music organization. They describe systems that can be effectively controlled live and with a very intuitive approach. The interfaces are used as media to recover human gestures and manipulations. However, both as spectators and performers, we're not able to infer any musical quality of the said tangible interfaces. In a way, the produced music still remains detached from a real source: the sound controlled or generated via the interface manipulation is still not the sound of a physical object.

The *Gamelunch* [22] – a sonically augmented dining table – follows a complementary approach: various sensing devices (force transducers, light and magnetic field sensors) enable to capture continuous interaction between humans and everyday (dining) objects, and the data sensed drive the control parameters of physics-based sound models. With its set of immediate and natural gestures and actions, the dining scenario sets a fertile context for an investigation of interactive sound generation. Simple actions such as cutting, sticking, drinking, pouring, grasping, stirring, mixing, have been analyzed in terms of source behavior and generated sounds. The current set of sound-enhanced interactive objects includes:

- **the fork:** a continuous friction/squeaking sound sonifies the action of lifting the fork while eating;
- **the knife:** the action of cutting is sonified as rubbing on a wrinkled plastic surface;
- **the shakers** (a set of bottles for making cocktails): interactions and correspondent sound feedback are addressed to bartenders. Free, yet energetically consistent sonifications synesthetically represent the qualities (alcohol content, taste,

<sup>4</sup> F. Gmeiner, "The Table Recorder: Instrument for everyday life's patterns," <http://www.fregment.com/table>

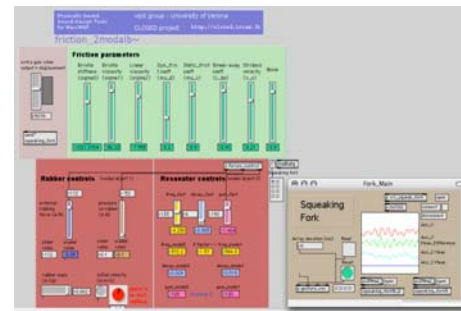


Figure 1 - Max/MSP patch for the fork.

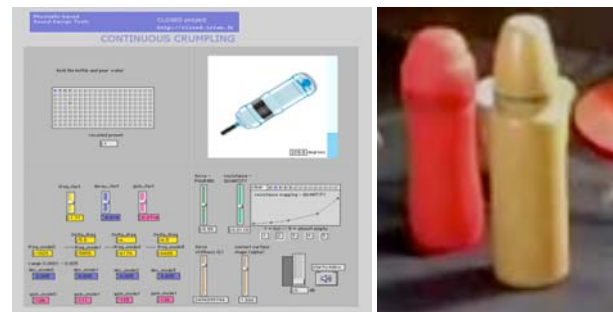


Figure 2 - Max/MSP patch and details of two top dressing bottles.

flavor, color) of the liquids. The continuous sound feedback informs also about the quantity of liquid that has been poured;

- **the decanter:** the action of pouring liquids is sonified as a continuous friction/braking sound feedback;
- **the sangria bowl:** the rotation of the ladle is sonified by means of a dense granular crumpling sound, as the sound produced by footsteps on the sand;
- **the salad bowl:** continuous dripping and boiling sounds are coupled with the action of stirring and mixing the salad;
- **the tray:** during the action of balancing the tray while serving beverages, continuous dripping and burbling sounds inform about its inclination.

Our aim is now to develop a brand new solmization system for these sonically augmented artifacts as that already existing for crafted musical instruments or for found objects.

## 6. EVERYDAY MUSICAL INSTRUMENTS

Focusing on the more immediate musical aspects of the dining scenario, we extracted cutlery and dressing bottles as candidate prototypes of SAFOs.

For the realization of the cutlery and bottles prototypes, we made wide use of the Nintendo Wii Remote controller since it provides an ergonomic handle, plus 3D accelerometers and a set of buttons that can be easily interfaced with our sound synthesis engine.

While maintaining the type of sonification discussed above, we focused on creatively exploring and pushing the boundaries of the sound design space. Three aspects are considered: 1) Availability to the user of a wide range of sonic material to work with. This happens by dynamically modifying the configuration of the

physics-based sound models during the interaction. To this end, we created families of parameters configurations among which to morph; 2) Thanks to the possibility of recording gestural data, it is possible to interact with gestural loops in a “sequence and playback” style; 3) Interaction modalities (configurations) are investigated in order to set basic musical gestures (as e.g., bending or finger-picking for a guitar). In detail:

- **the cutlery:** both the fork and the knife make use of the friction sound model. By exploiting combinations of buttons and movements, users can range over different presets, or effectively and reliably drive the control parameters of the sound model, such as the stiffness and viscosity of the interaction, or the mass and the resonant qualities of the objects (Figure 1);
- **the bottles** make use of a continuous-crumpling sound model [23]. The available control parameters are the stiffness and shape of particles, and material resistance as a metaphor of the present quantity of liquid (Figure 2);
- **the steak configuration:** typically when holding the fork with the left hand, and the knife with the right one;
- **the pasta configuration:** when holding the fork with one hand, and a dressing bottle with the other.

## 7. CONCLUSIONS

In this paper, we present a development in musical direction of our former work on sonic interaction design for artifacts. Some examples of what we called SAFOs are illustrated. These new instruments reflect the impulse of giving voice to everyday objects that belongs to musical traditions of every time and culture. This practice is here brought to the present by making use of current technologies and interaction design.

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