A Material Computation Perspective on Audio Mosaicing and Gestural Conditioning

ABSTRACT

This paper discusses an approach to instrument conception that is based on a careful consideration of the coupling of tactile and sonic gestural action across the layers of physical and computational material in coordinated dynamical variation. To this end we propose a design approach that not only considers the materiality of the instrument, but leverages it as a central part of the conception of the sonic quality, the control structure, and what generally falls under the umbrella of ”mapping”. This extended *computational matter* perspective scaffolds a holistic approach to understanding an ”instrument” as gestural engagement through physical material, sonic variation, and somatic activity. We present some concrete musical and installation performances that have benefited from this approach to instrument design.

Keywords

Topological Media, Computational Matter, Mapping Control Structures, Sonic Gestures, Enchanted Objects

1. INTRODUCTION

In the case of digitally-based instruments, there has been much focus on defining new instrumental systems by mimesis of acoustic instruments (e.g. digital clarinets, zithers, guitars) and as instrument-inspired interfaces which seem themselves in direct evolution of acoustic performance tradition [7]. At another extreme, it has been noted by Magnusson [6] that often times the tangible and immediately perceivable interface of digital instruments - what might be thought of as the body - is merely a shell. Rather, he contends that the expressive potential of the instrument is (often) situated in the composed symbolic instructions of the designer, rather than in the absent resonant, material properties. For example, through an elaborate sequence of musical events that are shaped through “higher-level” control of musical material by a performer. This point of view considers musical instruments as “cognitive extensions” of human musical thought, and expressiveness as the navigation of composed structures in the act of performance. This trajectory of instrument design has been articulated by Schnell and Battier [15] as process of the dematerialization of the instrument – of the progressively increasing electromechanical and now computational mediation of the coupling between somatic-gestural movement and sonic result. In re-establishing this coupled link between action and sound, the nature of the representation that one is introducing needs to be carefully considered. This includes the musical nature of the representation – for example the piano very strongly encode western musical values into the design – as well as the level of immediacy and expressive intent that is being represented. One must consider whether they are designing for an interface wherein large musical structures are “steered” or triggered by performer (at one extreme), or the moment-by-moment actions defined at the lowest level by physical performer action (at another extreme).

In this paper, we propose a ”material computation” ([19]) approach to rethinking the representations of musical thought and gestural engagement that are introduced in the process of coupling somatic action with sonic variation. We feel that it is productive to move away from a purely mimetic conception of digital performance systems, and from classic paradigms such as that of composer and interpreter [3]. In fact, we do not pre-suppose that musically-relevant excitations are only those that arise from the hands or mouth of a singular human performer. However, we do not suggest giving up on gestural immediacy and the physicality of the instrumental system in making this shift. Just as Van Nort [21] has proposed to consider instrument design through the lens of the sonic gestural affordance of a given system, we propose to consider gestural potential of matter as part of the design process, following on previous work [Removed for Anonymity]. By this we do not mean simply the physical properties of sensing technologies, but the encoded gesturally and computationally modulatable potential of physical matter itself - the spatial and temporal encoding of gestural potential - and how this is coupled with environment, human interaction and sonic output in continuous and connected fashion.

These are a constellation of forces at work, ones which are surrounding but external to the black/white box systems view of the instrument. To this end we propose a design approach that not only considers the materiality of the instrument, but that leverages it as a computational substrate. Such computational matter then becomes a central part of the instrument’s conception of the sonic quality, the control structuring and what generally falls under the umbrella of ”mapping” design. As we will discuss, this extended computational matter-centric view is of benefit towards holistically understanding an “instrumental” gestural engagement, as it is realized through physical material, sonic gestural matter and felt human engagement.

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2. CONTINUOUS MATTER, CONTINUOUS RESPONSE

The world around us is full of rich sounding matter, affording complex sonic experiences through our physical engagement. Naturally, this was articulated early on by Cage through his explorations of amplified objects [5]. This was also artfully expressed and systematized by Tudor, through his Rainforest series of works [2] which highlight the intelligence and beauty found in deep vibrational interactions between sonic and physical materials. In our work, we further augment, enrich and transcend the natural tendencies of matter to transcode gestural manipulations into audible sounds and tactile sensation. Simply placing a contact mic on a resonant material and skillfully manipulating it does already afford an extremely rich instrumental palette, which is the starting point for a countless number of experimental music performance practices. We extend this further by taking a material-computation approach to deterministic couplings with such manual engagement; in order to allow for the full thickness and boundlessly open set of experiences that are potentially realizable through interaction with computationally-enriched matter, we avoid strongly determined systems which recognize, learn or model specific sonic/haptic audio interaction or human experience.

Rather, to enable the continuous richness of potential computational response to non-schematized gesture we focus the design on the considered coupling of physical matter and sound synthesis/processing techniques. This includes the highlighting of natural affordances of vibrating matter, as we wish to transmute (augment/enrich) its given tendency to yield audible acoustic energy whenever manipulated. In addition to static qualities, there is an implicit temporality which arises through viewing the material as computational matter: through its encoding of gestural potential in a spatial form. This is written on its surface, in the folds, the density, etc. and this comes into consideration in the course of designing control structures.

In this work, this design approach to computationally enriching matter has been realized by audio-mosaicing the haptic-sonic gestures through corpus-based concatenative synthesis (CBCS). This equally accommodates gestural engagement with physical objects, whole body interaction, as well as the augmentation of sonic material in live performance. We will use specific examples to illustrate the philosophical underpinning and concomitant challenges of our design approach, but first we briefly describe CBCS and give an overview of related work.

3. CBCS IN SONIC INTERACTION DESIGN

3.1 CBCS

Corpus-based concatenative synthesis (CBCS) methods use a database of sound snippets to assemble a desired sound according to a target phrase. Recent developments in CBCS ([17]) enable real-time sound generation by navigation through a multi-dimensional descriptor space informing unit selection within the corpus and giving access to specific sound characteristics.

The *corpus* is a large database of *units* of either prerecorded or live-recorded sounds, that have been segmented and descriptor analysed in order to be placed within the database, according to their sonic characteristics. Depending on the segmentation method used, units can be of any lengths and often include any combination of differently-sized fragments such as grains, phonemes, notes, beats, and phrases. Descriptors are sonic characteristics (e.g. temporal, spectral, harmonic, and perceptual features) extracted from the given unit and/or meta-data (e.g. instrument class) attributed to the units. Units are selected, concatenated and played from the corpus based on a *unit selection* algorithm to best match given target specifications, usually in the sense of minimizing a weighted Euclidean distance while possibly taking a constrainable concatenation quality function into account.

3.2 Audio Mosaicing Sonic Gestures

Audio-mosaicing [18] can be seen as a special case of CBCS wherein the target is set from the real-time descriptor analysis of live audio input. One may use a versatile and efficiently controllable sound source such as one's own voice, or the sound of material vibration transmitted through contact mics as a means to exploit the target corpus. In this paper, we use audio-mosaicing as a primary technique in our design of instrumental systems, and the cataRT system has provided the perfect platform for exploration of these ideas for a variety of reasons. Most notably:

1. The cataRT system is implemented as a modular framework within Max/MSP using the FTM, Gabor, and MnM extensions [16], whose optimized data structures and operators, statistical and matrix processing tools, and arbitrary time grain processing allows for the efficient realization of real-time continuous signal processing and data handling tasks.
2. It provides a flexible multidimensional mapping space.
3. It provides a modular framework, making it possible to reconfigure the system to adapt to a large number of scenarios. It also makes it easy to apply further transformations to the output via control of granular synthesis parameters.
4. It is a (relatively) sonically transparent tool in that it doesn't strongly impose a typical sound on composers and designers. This is due to the fact that the designer/composer has the choice and means to accumulate any arbitrary collection of sounds as base material in the corpus and exploit their concatenation with notable flexibility and precision through.
5. In the special case of sonification of haptic-acoustic gestures, as cataRT is aware of the context of the database as well as the target units, it can realize finely coupled responses to spectro-temporal nuances found within the input signal.
6. Through careful parameterization and integration, the flow of processing can happen continuously and with low latency, so as to be felt as happening concurrently with a given continuous gesture. [9].

We adopt cataRT for audio-mosaicing as a means to create novel sonic texture that are shaped in real-time in response to continuous nuanced gestures. In regards to control structures and representations of musical interaction that we raised in the introduction, this approach is chosen as it allows for control over the "inner" textural detail of sonic matter, as well as to the morphology of the gestural profile, for both input audio and sonic result.

4. ACOUSTIC CONDITIONING AS GESTURAL CONDITIONING: DESIGNING FOR MATERIALS TO COMPUTE

In the case of instruments based on contact microphones and manual engagement with physical objects, the textural and resonant nature of the physical material becomes a central component for consideration, along with the kinesthetic gestural interactions that are conditioned through the spatial and material structure of the object. For example, we have found that a vibration isolated wooden surface with an evenly distributed textural roughness, enough acoustic conductivity, short reverb time, and a balanced impulse response is ideal for transcoding a wide range of gestural manipulations carried out via human skin, nails, hands and light objects. Such an object will transmute gestural interactions across a wider timbral spectrum, and thus provides an optimal platform for the continuous differentiation and distinct amplification of subtle changes in the process of haptic-sound feature extraction and sonification. For example, consider the subtle differences in measurable characteristics of the acoustic energy that results from a fingertip rubbing across a surface with varying degrees of applied pressure. In such a scenario, rough and sticky surfaces would provide a considerably improved acoustic response and a better signal to noise ratio in comparison with smooth and slippery surfaces.

Sounding and unsounding objects such as fruits, pine cones, combs, nails, the floor, and the human body can provide other computational operations such as band-limiting, resonance, convolution, smoothing, and spatial encoding [Reference Removed] that can be exploited to transform gestures from haptics into optimal acoustic energy. When talking of optimization, our focus is mainly on accessing, in the the acoustic response, the finest levels of intentionally nuanced gesture from noise (introduced by unwanted material resonances, microphones, cables, matter/environment, interfaces, etc). The question becomes: how do we extract useful and optimized information about the way (non)human performer interact with the objects' surface? How do we highlight important gestural nuances that yield minimal acoustic energy from the noise floor of an input system (instrument)? How can material thinking and material computation contribute to the design of haptic-acoustic instrument that distinguish the most subtle amounts of potentially intentional change in the input sonic gestures?

4.1 Conditioning the Audio-Encoded Sonic Gesture

Encoding gestures in audio ([22]) has the advantage of leveraging a high reliability path (due to the demands of the sound reproduction industry) with high data rates (44.1-198kHz) and low jitter (better than 1nS) . Another benefit is that we can exploit typical signal processing routines such as denoising, filtering, mixing, and compressing to condition and optimize the audio-encoded input gesture. This section focuses on a particularly unconventional implementation that repurposes recent Impulse Response-based Convolution techniques to diminish unwanted frequency imbalances and to optimize the input sonic gesture for use as a selection "target" in an audio-mosaicing environment.

While in our designs contact microphones have provided the best solution for picking up local acoustic energy from sounding matter, their sound is rarely balanced. This is due partially to the frequency response of the mic, its placement on the object, the method of its attachment to the object, as well as the frequency profile of the sounding object. It is impractical, time consuming and even undesirable to break down the estimated impulse response of the entire input system into individual profiles of the excitation objects, the sounding object, and the microphone. These elements are deeply coupled, with their interactions being as much a part of the system as a resultant mapping to sound features in the digital realm. We therefore are not looking for a modeled "signal", buried in "noise". Rather, we seek to condition salient gestural responses within the signal, but the entirety of the noise is in fact a rich part of the relevant signal. The challenge is thus to generate such a conditioning that satisfies a wide range of gestural manipulations arising from a variety of contextually-relevant excitation means such as feathers, shells, marbles, skin, and fingernails.

Our proposed method is effective, yet purposefully unconventional and imprecise, as the very notion of a "correct" or "flat" frequency response is nonsensical or at least highly context dependant and subjective in a given haptic-acoustic sensing system (this being due to the lack of a sensible reference and to the fact that these input systems are non-linear, dense, and continuously distributed.) That said, in most cases we have been able to even still identify major frequency imbalances. Often these imbalances mask and diminish other desirable features in the sonic gesture and diverge the musical interaction context, as the prominence of an unwanted feature (or noise) could stray the audio feature selection process and lead to the constant sonification of a static structural feature instead of dynamic profiles of the input gesture.

Our implementation uses the Max/MSP release of the modular, low-latency and lightweight HISSTools Impulse Response Toolbox ([4]) to improve the frequency balance of the input haptic-acoustic signal in real-time. We first measure the IR of the input system via an excitation signal, then we carefully smooth and further condition the IR estimate. Then we use an inversion of the estimated IR signal to as a convolution filter to improve the incoming sonic gestures.

Following [4] it is viable to use an arbitrary excitation signal to measure or estimate the IR of a system. Although such signals are unlikely to be optimal, we have found that they are satisfactory for our goal of attending to the more extreme imbalances in the response of our input system. Also, in most applications dealing with IR correction of systems it has been repeatedly observed ([4]) ([1]) that smoothed approximations of the frequency response and relaxation of the requirements for exact correction lead to dramatically improved results.

One major problem arises from the conception and incorporation of a "known" excitation signal to be used by the software as reference for measurement. To improve the workflow, for practical reasons and to make it possible to calibrate our instruments on the fly our solutions do not involve sending software driven signals (such as colored noise or ESS sweeps) from the software to the object (with transparent transducers for example) and picking them up for IR estimation. Instead our solution evolves around a much more arbitrary process where a diverse range of loud and quiet percussive actions and gestural manipulations are applied to the sounding object. We record the resulting sound through the contact mic as well as a flat condenser mic to compute a relative IR. Then we compare the contact-microphone's signal to emulate the results from a tonally optimal type (dpa omni) and position. The ideal balance retains the benefits of the piezo pickup while correcting for extreme frequency imbalances of our input system that are not as prominent in the condenser microphoneÕs signal.

We adopt the method of [4] and smooth the recorded signals prior to deconvolution. Then the estimated IR is further smoothed if needed, inverted to minimum phase, truncated, faded and normalized. The smoothing and regulation process are essential in defining the characteristics of the filter and require careful calibration and adjustments.

4.2 Haptic-Acoustic Transcoding

Acoustic surface sensing, when digitally incorporated with a non-reductionist sonification strategy, can take full advantage of the richness of the feeling of touch and thus enable the performers to rely solely on felt engagement with real matter, discovering and inventing their own repertoire of meaningful gestures in the process. Intricate gestural nuances are already carried in the audio excitation signal, as noted in [14]. In our case, this allows for considerable depth of gestural engagement, even before the added layer of CBCS. For example, in previous work [11] we have designed the continuous potential of computational response through an architecture that implements acoustic sensing coupled with context-driven physical modeling sound synthesis [Reference Removed]. The input audio signal was used to excite a set of physically modeled membranes/resonators and set them into vibration (within IRCAM's Modalys environment). Additionally, various high-level descriptors were extracted from the input to modulate the physical attributes of the resonating membranes, allowing for additional controls such as pitch bend, dampening, and spread . This enabled the participant to invent a wide range of gestural vocabulary and nuance with physical consistency between action and sound, without reducing the audio-encoded gestures to a strongly-modeled set of human gestural actions.

This use of physical modeling augments the materiality of objects and allows for the infinitely rich and nuanced variations of the input audio gestures to be amplified and transformed. With any one instance of a physical modeling synthesis however, the performer is restricted to a more or less uniform timbral universe specified by the sonic characteristics of the synthetic physical model and its couplings with natural matter and gesture. While the instrumental potential in this system is already vast, we are interested in control structures which allow us to adapt to differing qualities of timbre and output sonic gestures as well as to play with different action/sound gestural couplings in a poetic fashion.

4.3 Haptic-Acoustic Transcoding through CBCS

Building on this material-computation approach to the design of haptic-acoustically driven instruments, we focus on the use of CBCS for those reasons we have outlined in section 4.1. This builds on earlier work on the live audio control of CBCS (insert references here). Our design process leverages the synthetic parametrization of these software models, thought of as computer models of complex resonators; where software-domain computational processes are always co-dependant on the computational properties of matter. We use CBCS to computationally enrich matter while keeping in mind that computation as a potential property of matter does not take place in any obvious place.

Even if often our goal in the transparent coupling of action and sound is to construct perceptually singular morphologies, audio mosaicing has not necessarily been chosen for its tendency to perfectly mimic and imitate the target gesture. A considerably attractive quality of audio mosaicing arises from its exploitation as a multi-dimensional platform for the conditioning of the potential degree of semblance of the resynthesized sounds to a given target phrase while keeping the continuous morphologies of the target phrase intact. The target thereof could be thought of as an abstract gesture-template consisting of feature contours and their time-dependant variables.[20]

When using the input haptic-sound as "target," CBCS permits the temporal profile of morphological continuities to be imprinted onto any arbitrary collection of sounds. This is a very rare and desirable (non)compromise where it is possible to preserve morphological continuities of the audio-encoded gesture in the sonification process and yet retain novel compositional control over the timbral qualities of the output.

5. DESIGN INSIGHTS

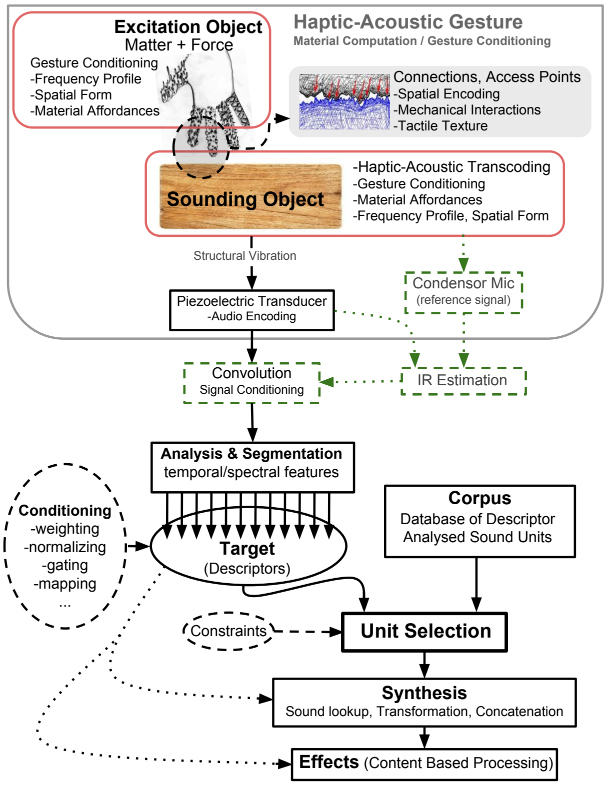

Figure 1: Audio Mosaicing Haptic-Acoustic Gestures

5.1 Descriptor Conditioning

We have experimented with possible transformations (calibrating, offsetting, normalizing, scaling, re-mapping, modulating) of the target audio descriptor (input: audio encoded haptic-acoustic gesture) so that the descriptor values are optimally adopted or recontextualized in order to efficiently exploit a given corpus (source sounds). First, in respect with the material affordances of the sounding object and the characteristics of the source material, a prioritized unit selection is parametrized by adjusting weights of each order dependant descriptor. Then, in order to obtain perceptually differentiable results from fine gestural nuance, we normalize the target descriptors and map them to the full range within the corpus. Further, in contexts where sonic resemblance and mapping transparency is not the main focus, one can freely scale, reverse, offset, swap and re-map the descriptors, without upsetting the rationale consistency of co-dependanct descriptors. For example, when sonically augmenting unsounding objects with non existing or static pitch features and yet needing to have some gestural control over pitch, one might want to explore mappings from arbitrary descriptors to pitch.

Optimization and conditioning of the descriptor space for efficient exploitation of the corpus is at the moment time consuming and parametrically multi-layered and complex. In the future we hope to make this a quick and wholesome process through a useful UI leveraging careful re-thinking of this system as complex whole were the response of the system is not shaped through adjustment of many co-dependant variables such as: input volume, signal conditioning, segmentation and analysis settings, descriptor calibration and transformations, descriptor weights, choice of source sounds and their segmentation method, synthesis parameters, post processing, etc. All of these mentioned layers at the moment need attention and calibration and a change to any of these layers has effects on the behaviour of the system as a whole and would require most other parameters to be re-examined. We hope to simplify this calibration process into a singular process of interaction design in a unified and visualized correlation space.

5.2 Composing Gestural Couplings

We are currently investigating the mosaicing of rapidly evolving tactile textures that result from complex mechanical interactions leading to the generation of transient impact micro events: brushing, squeaking, fire, etc. While CBCS with a large corpus could facilitate the concatenation of sounds with inherently similar temporal profiles as the target units, the real achievable resolution of the morphological changes are often lower that one would expect for particular gestural expressions. Furthermore, unit selection within cataRT is performed locally without considering the concatenation quality (the similarity between to neighbouring units). While a solely local unit selection algorithm provides an altogether preferred method for empowering the data-driven aspects of CBCS, in some cases it contributes to a discontinuous quality in the perceived morphology. For example if you wish to preserve the inherent spectral and temporal profile of the sound of a cat purring then concatenating units larger than 100ms would highly ambiguate the morphologies of the target sound and lower grain sizes lead to perceptual inconstancies where a smooth morphology is needed.

When seeking the solution to this problem (in the context of computational sounding matter), we constantly ask ourselves: -at what point, as far as humans are concerned does the sound become the thing? When do the kinesthetic and tactile experiences establish a strong enough perspective link between the apparent source and the implied, consequent sound? While this tight coupling is easily achieved through physical models, with audio-mosaicing we often find unproductive ambiguities, specially when we wish to use a limited sonic palate as source sounds for aesthetic reasons.

We are seeking solution for this and at the moment we have implemented attempts to dynamically vary the synthesis engine's grain size and grain adsr envelope based on higher level features extracted from the input (audio-encoded gesture). For example if the input is drone-like and smooth (like breath, whistles, brushing a smooth surface, etc) then a smooth adsr with longer grain sizes might be desirable. However, if the input is continuous yet very rough and complex as in scenarios where many many distinct acoustic interactions need to be distinguished and concatenated (like the sound of fingernails slowly moving across a very rough wooden surface, gurgling, purring) then it would be wise to decrease the grain size to the 30-70ms range and use a sharp attack and decay time (0-5ms) in order to create a complex, grainy, rough texture composed of many elements. (NOTE: we acknowledge that texture re-synthesis is one of the given benefits of using CBCS through efficient exploitation of any large and diverse enough corpus. However the method mentioned above adds a useful option for creating sonic diversity and aesthetic flexibility for creating interesting continuous morphologies with smaller corpuses. Tremblay and Schwartz [20] also suggest a need for a binary descriptor for partially dealing with the complexity of the presence of transients within segmented grains and to efficiently couple these transients with the target with low latency.

1. small grain sizes (50-200 ms) assure that the sonification feels temporally coupled with the gesture. Larger grain sizes (200-1300 ms) ambiguate blur the gesture to sound relationship but depending on the context and target material could lead to musically interesting results.

2. Two or even several synthesis modules on the same target corpus gives us the option mix different layers to quickly obtain a desirable response on the fly. For example, short grain sizes with minimal variation could be used as prominent sonic layer to provide optimal coupling with the target sound's dynamic morphology while another granulator with much longer grain sizes and extreme pitch variations could be added underneath to create a coupled shifting soundscape in the background. We could also add another layer driven by onset direction, fine-tuned to only reponde to distinct and louders impacts.

6. MATERIALS PERFORMING/PERFORMING MATERIALITY

We follow our previous work ([19]) in taking the stance that matter can sometimes be a computational substrate. A material computational perspective on the design of New Interfaces for Musical Expression can help us, effortlessly and at once, to remove at least from our design metaphors problematic boundaries of performer/performed, instrument/score, intention/noise, software/hardware, matter/thought, digital/analog, speculation/action, and etc. Computational matter compute concurrently and densely making it impossible to distinguish between performer intentions and material processes. As designers of interfaces we can employ this inherent indeterminacy and inescapable non-linearity of computational matter to design humanely for incalculable associations of actions/agents doing arbitrary things.

6.1 Example: Gesture Bending

In a recent workshop at the [Name Removed], the first author employed acoustic-sensing and audio-mosaicing instruments from the *Gesture Bending toolkit ([10]) to prepare the floor as an instrument.

*Gesture Bending, a generic term coined by the first author, refers to the poetic transformation, prolongation and enrichment of gestures through staged and unstaged technical mediation of movement and here specifically through the incorporation of real-time sound instruments and computational matter. The goal of Gesture Bending is to continuously enact persuasive conditions for the transformation of the discursive networks of meaning production in the embodiment of movement. It can for example lead to the signification of an empty gesture or the abstraction of an inherent signifier (ie. within a beat gesture). Pervasive Gesture Bending can lead to the emergence of social experiments, multidimensional compositions and the creation of conditions that invite inhabitants to synergetically improvise with a hybrid expressive force. ([10])

We populated the space with diverse set of activities and social events. The participants gestures not only lead to unexpected musicality but to narratives about shaping relationships with the immediate world and recognizing daily life and the material world as a platform for play and for refined practice. Participants discovered that their everyday movement can create intricate sonic textures ([12]) and developed their own unique vocabulary of sound generation to sculpt musical events via engagement with the floor.([9]) Others set objects such as tennis balls into motion, allowing objects to effectively "perform" music. ([8]) Without needing to model the performers' cognitive decision making processes, through audio-mosaicing we are able to amplify and augment the acoustic energy that is produced as a result of arbitrary material interaction. Thus, any physical gesture can effectively augment material objects with gesturally-conditioned sound, augmenting those objects' material qualities. Through interactively varied augmentation of the object's natural acoustical response, an a priori distinction "synthetic" and the "natural" and the "performer" and "performed" becomes unnecessary. Performing a score or improvising music could turn into a hybrid mode of engagement and perception borrowing elements from gaming, playing, building, day to day living practices, puppetry, and performance art.

6.2 Example: Practices of Everyday Life | Cooking

"Practices of Everyday Life | Cooking" ([13]) is the first part in a series of performances and installations exploring how everyday gestures could become charged with symbolic intensity and used for improvised play. A performance choreographed around a chef and sonified objects: fruit, vegetables, meat, knives, pots and pans, cutting board and table.

Cooking, the most ancient art of transmutation, has become over a quarter of a million years an unremarkable, domestic practice. But in this everyday practice, things perish, transform, and nourish other things. By augmenting the meats, wood and metal with sound and painterly light, we stage a performance made from the movements and gestures of cooking, both high cuisine and everyday. The performance features a dancer who is also a virtuosic chef who wields foods, knives, pans and spices transmuted gesturally into real-time sound instruments. Within our responsive scenography system, every cooking process is transformed into an environment thick with aroma, light, video, sound, movement, and objects. A knife sleeking against another knife, carrots vocalizing their unfolding mutation into a cacophonous a cappella, the sizzle of hot oil mosaiced into a downpour of Bartok pizzicati along with the aroma of onion and garlic immerses the audience in an ecology of remembrance and anticipation. At the end, the performer offers the audience a chance to taste the dish that is prepared.

The participants are given a chance to extract new and unbounded forms, meanings, affects and percepts from the otherwise familiar situations such as cooking. The emergent mental modalities are more likely to be in closer contact with ecological and mental complexities of socio-gestural behaviour than if they were left centralized/colonized by the subjugated tonality of standardized mentality.

"Practices of Everyday Life | Cooking" utilizes the Gesture Bending software system, and leverages material thinking and acoustic sensing techniques, some of which have been mentioned in this paper, to symbolically charge everyday actions and objects in ways that combine the composerÕs design with the performerÕs contingent nuance. Our material computational design allows for any potential movement at all by the performer or the objects to turn into potentially musical gestures. This removes the burden of modeling the human experience in our designs and instead allowing for such notions as meaning, intentionality, expressivity, noise, musicality, and even performer, performed and speculator to freely arise from the context established in the moment of performance together with the theatrical apparatus of expectation.

7. CONCLUSION

"Material computation" refers to the non-digital processes of computation that happen in physical materials that do not follow the logic of a finite state machine. The formal separation of a technical object's functions into components is an abstraction. Separating the design of human interaction as a symbolic communication problem from the design of the material is an abstracting separation that we claim introduces as many problems as it may solve.

Figure 2: Practices of Everyday Life | Cooking

We have introduced an alternative conceptual and practical approach adequate for manipulating computational media from a material computational perspective. This approach takes into account qualities extending material qualities like mass, density and elasticity. We have demonstrated the incorporation of audio-mosaicing and CBCS techniques into a disciplined practice of music performance.

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