

# MUSICKING THE BODY ELECTRIC

## THE "BODY:SUIT:SCORE" AS A POLYVALENT SCORE INTERFACE FOR SITUATIONAL SCORES

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### ABSTRACT

Situational scores, in this paper, are defined as scores that deliver time- and context-sensitive score information to musicians at the moment when it becomes relevant. Mnemonic (rule/style-based) scores are the oldest score models of this type. Lately, reactive, interactive, locative scores have added new options to situative scoring. The body:suit:score is an interface currently developed in collaboration of four labs at Concordia and McGill Universities in Montréal - an interface that will allow the musical use of all four types of situational score. Musicians are clad in a body-hugging suit with embedded technology - this suit becomes their score interface. Ultimately intended to enable ensembles to move through performance spaces unencumbered by visual scores and their specific locations, the project currently enters its second year of research-creation. The paper discusses the closely intertwined technological, ergonomic, performance-psychology-based and artistic decisions that have led to a first bodysuit prototype - a vibrotactile suit for a solo musician. It will also discuss three étude compositions by Sandeep Bhagwati and Julian Klein for this prototype, and their conceptual approaches to an artistic use of the body:suit:score interface. Finally, the paper discusses next steps and emergent problems and opportunities, both technological and artistic.

### 1. Towards the body:suit:score

The practical need for a non-visual score interface such as a body:suit:score arose in performances of comprovisation scores that rely on musicians freely moving in space.

In Bhagwati's scores "Racines Éphémères" (2008) for eight musicians, obbligato conductor and sonic trace amplifier and "Nexus" (2010) for five networked musicians moving through urban indoor and outdoor spaces with obbligato improvisation software, the musi-

cians realize complex spatialisations and sound trajectories by walking while interacting with other musicians and/or the audience. They also integrate auditory and visual cues from the performance space and environment and, at certain moments also conductor's signals, into their realization of a comprovisation score.[3],[4]



**Figure 1** "Nexus" at Concordia University (May 2010). Guy Pelletier (flute) and Lori Freedman (bass clarinet)

In these comprovisations, not only the delivery of score information to the musician, but its very meaning crucially depend on the situations the musicians are in: their position in the space, their physical closeness to and their musical relationship with the other musicians of the ensemble.

At the time, different scoring strategies were employed: In "Racines Ephémères", about 8 music stands per performer were placed in strategic positions. Musicians could not move at will or continuously, they were constrained to follow 'their' trajectory, with frequent stops. In 'Nexus', as musicians roamed freely and largely unpredictably throughout a city block, the score became a web of rules that had to be learned by heart. These rules consisted mainly of reaction protocols to either the music from other players sent to their backpack loudspeaker through the network - or to contextual cues, such as imitating the rhythms of conversations, or signaling the crossing of an indoor/outdoor threshold by a pre-defined phrase. Musicians also had to memorize different pitch

sets, each corresponding to one of the other four instruments.

Though the performances worked and were received well, it became clear that both approaches to scoring for moving musicians had serious flaws: both burdened performers with unnecessarily distracting non-musical choices and mental constraints: in ‘Racines’, the use of space could not spontaneously be adapted to the music arising from improvisation, musicians could not translate musical affinity into spatial proximity. And in ‘Nexus’, musicians were worried about potential memory lapses that could destroy the web of musical interactions. Moreover, learning such non-traditional constraints and rules well enough to recall them quasi intuitively during performance proved to be quite daunting, especially for improvising musicians. The learning curve for these pieces turned out to be quite steep.

“Musicking the Body Electric” is a four year research-creation project funded by the Canadian Social Sciences and Humanities Council (SSHRC). In its envisaged final incarnation, the body:suit:score we work towards is conceived as an exemplary instance of a polyvalent interface for situational scores that would address and provide solutions for most of these concerns.

## 2. SITUATIONAL SCORES

When we follow a linear score – whether on paper or on screen – the passage of time reveals context-invariant information structures that predate performance. Information in such scores is accessible at all times, at least in principle.

Situational scores, as defined here, are scores that do not build on such linear, pre-existing information structures. Information in these scores is only available ephemerally, i.e. while it is displayed or accessed in a particular context.[4], [14]

Four principal kinds of situational score can be discerned:

- 1) **RULE-BASED SCORES:** such scores best serve context-oriented musicking that does not assume any inherent temporal dramaturgy. Musicians have memorized a database of rules and sub-compositions, together with instructions about their appropriate contextual use. These are the oldest variety of situational scores, used for example in Indian raags or Arabian maqams, but also e.g. in John Zorn’s game-pieces.[10],[23] Their use is most prevalent within oral musicking traditions, for obvious reasons. As the richness and flexibility (i.e. the sensitivity to the sonic and aesthetic situation) of the music grows with the number of specific contextual rules, the number of possible relationships between these rules grows exponentially – as does the time needed to not only learn them, but also to understand how and when each new rule can be artistically and appropriately applied.
- 2) **REACTIONAL SCORES:** For the purposes of this paper, a reactional score is defined as a score that displays score information based on underlying processes, e.g. algorithms or data mappings (e.g. the current weather conditions), in a manner that cannot be influ-

enced (nor studied beforehand) by the player. The player thus plays the score largely ‘prima vista’ and must always react to new input. Most animated scores fall into this category. [17]

- 3) **INTERACTIVE SCORES**, then, are similar to reactional scores, with the decisive difference that either intentional input by the performer reading the score (buttons, switches, pedals etc.) or the music played by this performer or, even non-intentional information lifted from the performer (i.e. eye movements or electrical skin activity) is allowed to be a factor in the generation of the displayed score.[1], [5],[22]
- 4) **LOCATIVE SCORES:** The previous score types assume nothing about the actual performance situation, the musician’s body and its relationship to other people, the space s/he plays in etc. The spatial relationship between musician and score is conceived as being purely functional. Indeed, most musicians would probably claim that it has no aesthetic or artistic significance in the context of their performance.

This kind of abstraction from the performance context is impossible to maintain when the score is locative. Locative scores distribute score information in actual or virtual space: the musician thus moves within the information display, accessing the information available at a certain location. They thus add an aesthetic dimension to spatial musicking: sound production and meaning in locative scores arises not only from the decision when to play a sound, but also from the decision where to play it.

The paradigmatic interface for situational scores, too, seems to be the visual score, at least in the last three categories. Writing surfaces and/or display screens dominate the practice of scored music. [6], [12],[16],

The drawbacks of visual displays for musicians wandering through a space is obvious: they cannot see - not only where they will set their feet, but also what goes on around them. Indeed, the advent of screen displays has served to capture the musicians’ gaze more intensely than ever before. Whereas a written score always allows the performer some leeway, most reactional and interactive visual scores want the musician’s eyes to be on them every split-second. It seems reasonable to assume that the necessity for such intense visual attention distracts the musician from the sounds s/he is shaping.

This consideration also is the main reason why we, after some discussion, decided to not pursue visual head displays (i.e. augmented reality scores) as a viable interface for walking musicians. Instead, we opted to develop a body-suit as our score interface for situational scores - hoping that it would allow for more intuitive and centered musicking. [7], [9], [11],

## 3. The body:suit:score

The project we designed has three main stages, spread over 48 months.

**Stage 1 [monody]:** testing and design for a single suit with only vibrotactile elements; composition of min. two

“étude compositions” for this solo performer with this suit.

**Stage 2 [counterpoint]:** equipping the suit with various kinds of sensors, two études for two or three intercommunicating musicians

**Stage 3 [multiplicity]:** designing bodysize- and instrument-adaptable bodysuits that can be manufactured in small quantities. 2 Compositions for an ensemble equipped with bodysuits.

At the point of writing, 15 months into the project, we have completed Stage 1, and have embarked on Stage 2.

### 3.1. Ergonomics

Disturbing the musician’s reflexes and concentration is a major concern with vibrotactile elements. [19] Great care was taken to not place elements near or in performance-sensitive areas (these obviously vary for each instrument). [15] Detailed experiments determined basic data sets such as body resolution (how near can two elements be placed while still being perceived as discrete? One answer: closer on the arm, wider apart on the back) [18], body image (where can sets of elements be perceived as one coherent group?), and, of course, the influence of vibrotactile intensity (‘dynamic variation’) on the perception of the elements.

### 3.2. Intuitive Or Symbolic

In our discussions about the musical functionality of the bodysuit interface, two schools of thought emerged: the bodysuit as a kind of vibrotactile ‘screen’ with dense placement of elements that can produce intuitive seamless sensations - or the bodysuit as a message interface with sparse element placement that can signal symbolic content in great clarity. For reasons discussed below, we chose to not decide between these two approaches at this early stage. The first suit prototype offered characteristics of both: while a back interface was entrusted with ‘symbolic’ messages, leg interfaces displayed more ‘intuitive’ informations.

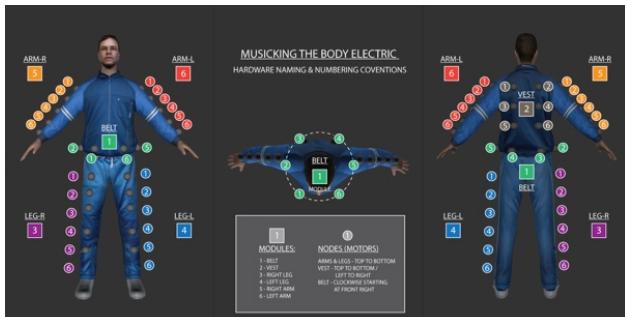


Figure 2 Distribution of vibrotactile elements on the body, with body zones differentiated by colours (see section 5.2.)

### 3.3. Look

As everything perceived during a performance contributes to its aesthetic meaning, especially when it is deemed to deviate from convention, we were conscious of the fact that a performance using heavily technological bodysuits could evoke all kinds of cultural references, from movie cyborg depictions to the body-alterations of

Stelarc. Such (sub)-cultural connotations, while sometimes helpful for a stage director, can also be artistically annoying to those whose medium is sound.

From the start, therefore, we aimed at integrating the technological elements of the suit (motherboards, vibrotactile elements, cables etc.) into the textile design – for example, all vibrotactile elements were sewn into the suit, connections inside the suit were stitched – and look like embroidery.



Figure 3 The back zone and the belt zone. The vibrotactile elements lie underneath the area between two connector endings emanating from each of the central boards.

The resulting suit prototype largely resembles normal concert attire. This ‘neutral artist’ look will permit composers, stage directors and musicians from other traditions or genres to add a costume layer suited to their artistic message or stage convention, while also enabling concerts where music is expected to be the only focus.

## 4. Score Information

The information displayed by a situational score interface can be of three basic types: analog, symbolic, and relational.

**Analog score information** is iconic (or sometimes indexical): it mimics (or echoes) the type of sonic performance it refers to. Some sonic parameters are best accessible through analog information: pulse (speed), dynamics (intensity), timbral evolution, even sometimes even pitch (especially with non-common uses of microtonality) etc. In conventional written paper scores, such analog informations are often represented by icons that extend over several notes, such as crescendi or slurs - but the structural limitation of written scores for the display of analog information has always been a major motivation for research into animated and interactive scores.

Most of the other information in a notated score is **symbolic** - signs by virtue of convention. Symbols are the main elements of the written paper score, as well as a major area in mid- to late 20<sup>th</sup> century score research, covering both extended instrumental techniques and extended scoring techniques.[20]

The third category, *relational* score information, has, despite many different attempts, [1],[3],[6] so far not been systematically explored or codified in written and visual scoring. The ‘relations’ referred to are those between different streams of musicking, between musicians. Relational score information is implicit in every ensemble arrangement, in every social setting involving music, and even in how musicians and sound sources (or scores) are placed on a stage or non-stage. Largely because they usually deal with conventional and mostly static arrangements, written scores have only rarely integrated such relational information. However, given the *raison d'être* for the body-suit-score interface – i.e. musicians moving while playing - such information becomes a vital, aesthetically highly relevant parameter: “Who do you play with?”, “Whereto do you direct your playing?”, “What/who do you listen to?”, “Whence do you get your next cue?” etc.

Finally, locative information also is relational: by letting the musicians experience where they are in the room, where they are in spatial or musical relation to the other musicians, by augmenting certain physical locations with embedded score information, the locative score affords the performers many additional types of insight into how ensemble playing can become aesthetically relevant - beyond the purely sonic.

We decided fairly soon that we needed the body:suit:score to be able to display and transmit all three types of score information. At Stage 1 of the project, relational information still was largely unexplorable, as we only worked with stationary solo performers, but the other two were exhaustively tested.

#### 4.1. Tactons

One consideration in every new score display or score design is the learning curve for the musicians. Analog information is fairly easy to absorb and follow, whereas new symbols must painstakingly be learned. At a later stage, we plan to develop game-like learning software for the musicians, replacing a score manual with interactive learning processes.

At this stage, however, we debated how we could at all create meaningful and easily retainable symbols for the bodysuit interface. [13] One member of the team, Marcello Giordano, already had - in another project with vibrotactile displays - developed a type of higher-order signal patterns he had named ‘tactons’ (in analogy to the word ‘icons’).[7]

‘Tactons’ combine semiotic properties of both symbol and icon. In a tacton, a few vibrotactile elements are arranged into a short ‘firing’ sequence which typically is repeated a few times: A tacton behaves more like an animated .gif than like a still image. Moreover, such short sequences can also be ‘phrased’ in ways that musicians already are familiar with: *staccato*, *tenuto* and *legato* in precise arrangements.

Tactons thus can carry a modicum of analog information - and this fact can be exploited to make a new vibrotactile symbol both easier to learn and easier to recognize in performance. Tactons also allow us to reduce the number of vibrotactile elements needed. Their

potential for versatile recombination of few elements allows us to approach tacton creation and tacton learning with high-level concepts that borrow from language: word formation, syntax, ‘style’.

Such concepts have proven to be crucial to their utility in performance: not all mathematically possible combinations of vibrotactile elements become easily recognizable tactons – only those that ‘make sense’ to the player, i.e. those that seem well-defined, unique in relation to others and can be understood as icons for the information they carry. Thus a tacton encoding e.g. the information “jump to the next section” will be better retained and recognized if the firing sequence in a line of six elements is **1→2→6** (where traversing the physical distance between 2 and 6 will be perceived as a jump) rather than, say, **3→2→3**.

### 5. Etude Compositions

At this point in time, the primary artistic question of any new score design or score interface must always be: Which music or kind of musicking could not be imagined, let alone be performed, without it? It seems to make no practical nor aesthetic sense to develop a new interface in order to perform existing music - or to perform music in a familiar way. To this end, the perspectives, needs and demands of composers and musicians should shape the design and evaluation of a new score interface.

In the body:suit:project, three embedded composers steer and influence the evolution of the interface. We chose to work with three very different composer-musicians to ensure a large variety of approaches towards musicking and composition, also to ensure that the resulting suit would not only serve musicking in one particular style, tradition or genre: Adam Basanta, coming from electroacoustics and installative art, approaches performers as sonic and installative elements in space; Julian Klein approaches musicians as if they were theatre actors and music as if it were their stage; and Sandeep Bhagwati represents both conventional written composition and inter-traditional practices of improvisation where musicians are artistic interpreters of the score.

This variety is evident in the first etudes they conceived for this project. While Julian Klein imagined the bodysuit as a means of virtually representing the real body of the musician, and was interested in how manipulations of this represented body would influence the live improvisation by the musician, Sandeep Bhagwati composed game-like, ritualized conceptual music spaces: an improvising musician exploring them would be guided, challenged and conducted by the score, which in turn was jointly controlled by a de-centralized conducting team. Adam Basanta’s etude was not realized due to other commitments, but it would have involved much less improvisation, using the score as a complex signaling device for composed sonic explorations of bass clarinet multiphonics.

#### 5.1. Klein’s Mannequin

Klein was interested in how people treat a person’s represented body (in the form of a dressmaker’s mannequin

covered with pressure sensors and vibrotactile elements) if they are alone in a room, and can interact with it as they wish.



**Figure 4** Sarah Albu performing Julian Klein's etude composition (Nov 4, 2015, Montréal)

Whatever they physically do to the doll elicits direct vibratory feedback, but is also transmitted to the singer in an adjacent concert room (Sarah Albu) who, in her own body:suit:score, feels an intuitive representation of this interaction. During rehearsals, Klein and Albu developed what he calls a "mise-en-musique": an aesthetic and behavioural stance enabling quasi intuitive musical reactions that shape her improvisatory response to the unforeseeable signals coming from the audience-manipulated mannequin. It is immediately obvious why such an idea would not be possible to realize with a visual score.



**Figure 6** Felix Del Tredici performing Bhagwati's "Fragile Disequilibria" with Jen Reimer, Joseph Browne, Max Stein and Adam Basanta on iPad controllers (matralab Montréal, Nov 4, 2015)

## 5.2. Fragile Disequilibria (Bhagwati)

While Klein used the entire suit as one contiguous score surface, Bhagwati divided it into four distinct score zones: back, belt, left and right leg. Each of these zones controls another parameter of improvisatory musicking: timbre, dynamics, interval structure, musical lingo (divided into three main lingo groups: bird-like, machine-like, and fluid-like).

Each bodysuit zone is separately controlled by a 'audi-ductor' who, while listening to the performance,

can issue change commands by sending specific tactons (The number of tactons used in any given piece is arbitrary. This score uses 16 tactons.)

A brokering software eliminates command overload to the performer by negotiating the current precedence of change commands. It also calculates overall commands such as tempo changes, silences and the end of the performance from the input by the four 'audiuctors'.

The performer (trombonist Felix del Tredici) thus needs to navigate a landscape of precise musical commands. These are unforeseeable, but not random – after all, he can non-verbally communicate with the four audi-ductors, and they, too, are instructed to issue their change commands 'musically', i.e. as an artistic commentary or guidance.

The negotiations between the 5 musickers (one acoustic and 4 conceptual) are the aesthetic core of this piece – how they change and challenge the improvisor to invent a music that fulfils continually changing layerings and combinations of the four parametric zones palpably shapes the "Fragile Disequilibria" of the title. The performer's audible but also visible mental juggling and his musical navigations could theoretically also be achieved via a visual screen score - but they would probably not offer the same intense concert experience for player and audience alike. As del Tredici described it once, "it feels different if the command seems to come from your own skin".

## 6. Conclusions

After a little more than one year of research and creation with and around the body:suit:score, several basic, but crucial problem zones around the representation of score information have successfully been addressed: 1) skin resolution for vibrotactile sensors; 2) a good understanding of instrument-specific performance-sensitive zones; 3) a basic prototype suit, tested in performance: both the distribution of technological elements and the necessary properties and constraints for materials and costume design have become clear; 4) various aesthetic approaches and three etude-compositions for the score have prompted a versatile and stylistically agnostic approach to our suit interface design. 5) artistic feedback from both musicians and audiences at workshop and conference performances largely encouraging.

The next years will see further developments as outlined above: while the basic functionality and a promising artistic uses have been established and successfully tested, the next steps involving contrapuntal interactions between multiple players and the technological and conceptual integration of sensors into the suit will pose a new category of research-creation challenges. While reliable wireless communication remains one of the major technical challenges, the new streams of sensor data emanating from the performers will pose new challenges to the composers: the two principal questions of all real-time data analyses, namely pattern recognition and pattern correlation must be addressed in a poetical manner.

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