BODY SUIT SCORE

musicking the body electric

SYSTEM DESCRIPTION SPRING 2018

a collaborative research-creation project by
matralab, XS Labs, IDMIL, and MBPL

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Text by Travis West and Sandeep Bhagwati

Research-creation towards the body:suit:score is generously financed by a 4 year SSHRC grant entitled* Musicking the Body Electric *as well as by the Canada Research Chair for Inter-X Arts.

With support from:

Social Sciences and Humanities Research Council (SSHRC)
Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT)
Hexagram Network
Milieux Intitute for Arts, Culture, and Technology
Textiles and Materiality Cluster

For more information, recordings, videos, photos, and in-depth texts, please consult the project webpage:

http://matralab.hexagram.ca/research/body-suit-score/

Conseil de recherches en sciences humaines du Canada

Social Sciences and Humanities Research Council of Canada

Canada

The **body:suit:score** project is a collaboration of four Montréal research labs.

matralab (director: Sandeep Bhagwati) is a lab for research-creation in inter-x arts at Concordia University whose researchers create new technologies, techniques, and aesthetical models for inter-x performing arts.

XS Labs (director: Joanna Berzowska) is a design research studio at Concordia University with a focus on innovation in the fields of electronic textiles and reactive garments.

IDMIL (director: Marcelo Wanderley) at McGill University researches human-computer interaction in music, the design of instruments and interfaces for musical expression, movement data collection and analysis, sensor development, and gestural control.

MPBL (director: Isabelle Cossette) at McGill University studies musicians' control parameters, e.g. their respiratory mechanics, in order to develop new student-centered science-based models for music pedagogy.

In everyday life, we listen to—and thus structure—the space around us: noisy objects move, we move through their sounds. That's what our ears are designed for. In concert music, however, most audiences and musicians have become stationary: with our ears fixed in one place, music appears to us as a delocalized sound atmosphere, mainly articulated in time. Could listening to music become as engaging an activity as walking in a landscape, as exploring a sprawling palace? Could we imagine new compositions that we can experience by moving with and among musicians who are themselves in movement? These new scores and the new music they offer could profoundly transform the way we listen to live music and establish new social functions, spaces, and roles for innovative artistic music. How could such mobile music build on the rich heritage and practice of written music—its polyphony, its well-articulated dramaturgy, its coordination in a split second between many musicians?

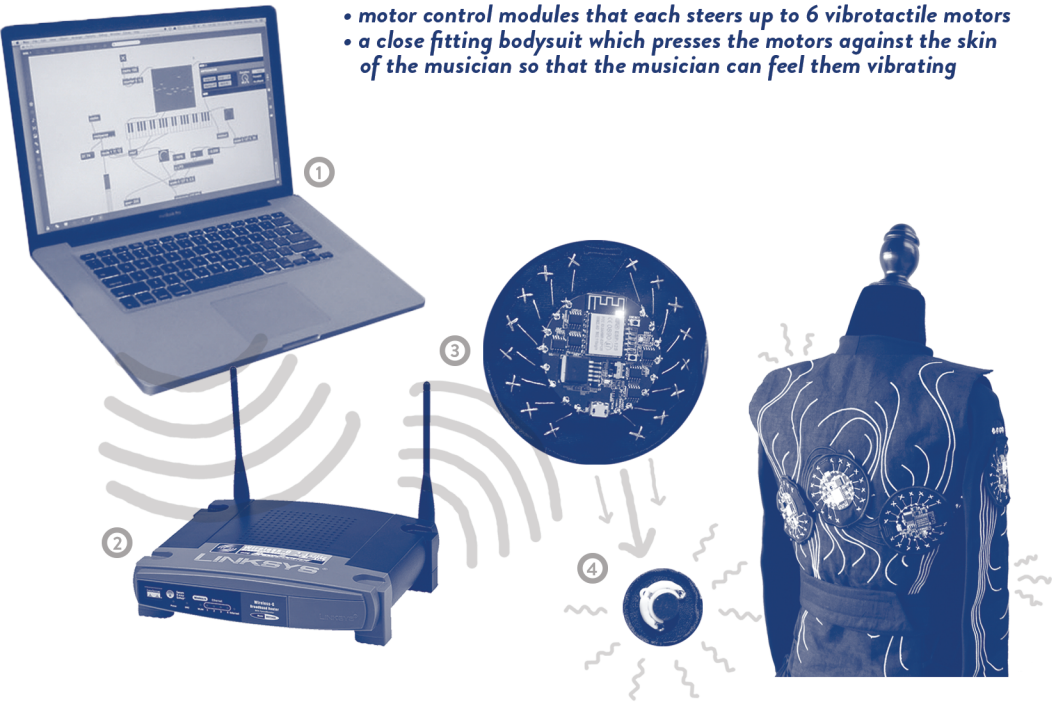
Since 2014, matralab at Concordia University has been collaborating with three other Montréal laboratories on a sustained intersectional research-creation project: developing a system that musicians can wear on their bodies, which can coordinate them in real time with the world, with a score, with other musicians through tiny vibration patterns on their skin. Several new types of compositions have been developed in collaboration with engineers, fashion designers, music ergonomics researchers, hardware designers, and software innovators. Who still wants to sit and listen to a world full of moving music?

“COULD LISTENING TO MUSIC BECOME AS ENGAGING AN ACTIVITY AS WALKING IN A LANDSCAPE, AS EXPLORING A SPRAWLING PALACE?”

:SYSTEM :OVERVIEW

The body:suit:score system consists of

- ***the computer conductor running a software patch that sends and receives control messages to and from the control modules***
- ***a wireless local area network connecting the conductor to the control modules***
- ***motor control modules that each steers up to 6 vibrotactile motors***
- ***a close fitting bodysuit which presses the motors against the skin of the musician so that the musician can feel them vibrating***



The body:suit:score allows a computer to individually control up to 66 motors worn by a musician all over their body, varying the amplitude and location of vibration to create a variety of sensation-movements, articulations, and textures, which can be used to convey whatever score or score-like information one might imagine.

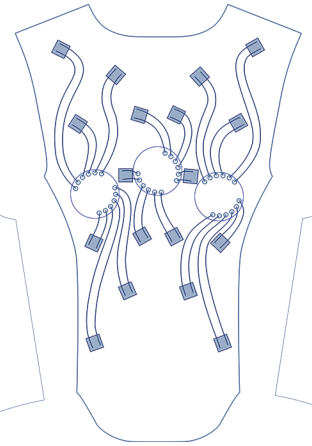
CURRENT SUIT

full suit: 11 boards + 66 motors

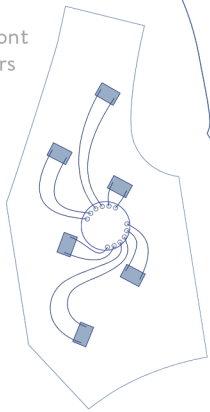
motor

circuit board

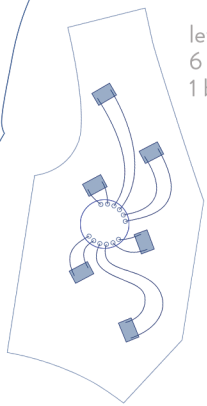
back
18 motors
3 boards

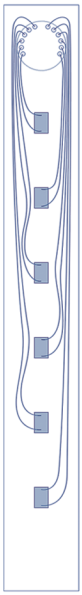


right front
6 motors
1 board



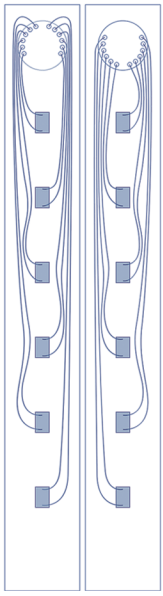
left front
6 motors
1 board

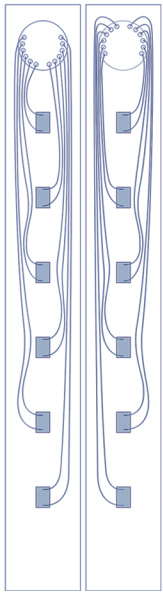




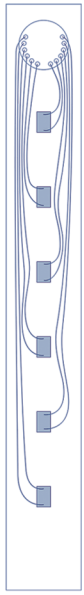
right arm
6 motors
1 board

right leg
6 motors front
6 motors back
2 boards





left leg
6 motors front
6 motors back
2 boards



left arm
6 motors
1 board

:TEXTILE :FEATURES

The body:suit:score modules are unique garments, both in how they are produced and how they are worn. Different performers in a number of distinct musical compositions must be able to use them within the same project. As a result, the body:suit:score designs prioritize fit, modularity, and washability.

The primary function of the body:suit:score is to position the vibrotactile elements at the appropriate locations on the performer's body and ensure a firm fit to efficiently transfer the vibration of the motors to the body. To this end, we use a combination of stretch and non-stretch fabrics as well as velcro and corset-like ties to adjust for size and body type of the performer.

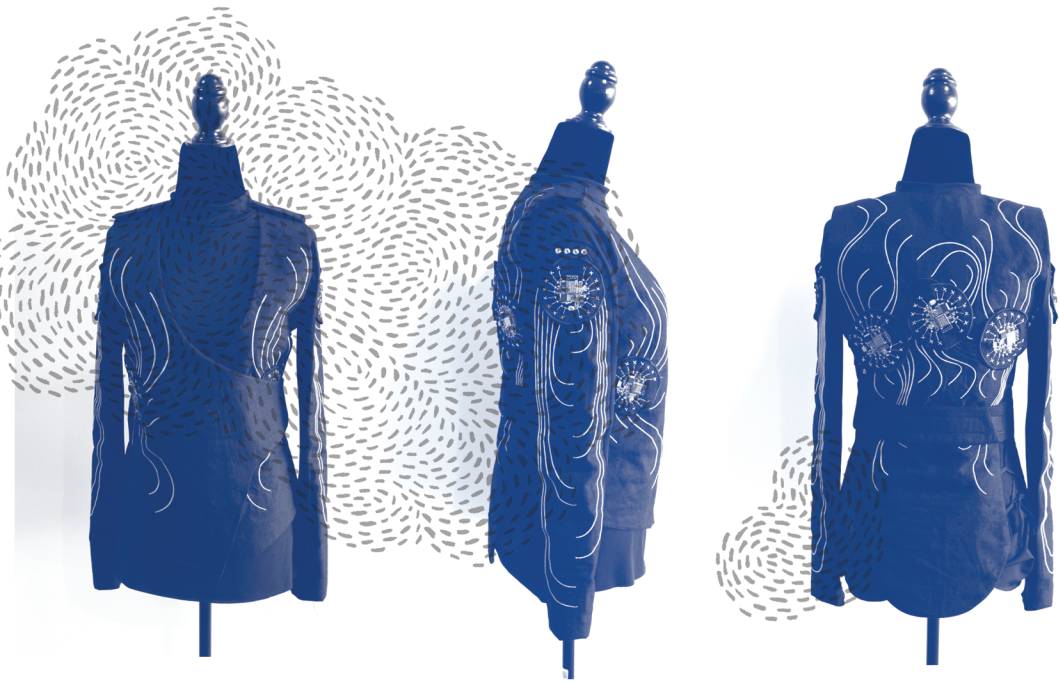
The suit consists of several garment modules that can be used independently from one another: the vest, the legs, the arms, and the belt. Connection between the motors and control modules is embroidered onto the suit using a Tajima Industrial Embroidery Machine, which lays down all the conductive silver thread circuits. The conductive thread is both flexible and washable. All hardware—batteries, control module circuit boards, vibrotactile elements, and LEDs—are attached to their respective locations using either snaps or polarized conductive velcro so that they can be easily removed in order to wash the garments.

The suit must be resonably close to the skin, but can be worn with thin garments underneath. However, the body:suit:score is also thin enough to be worn underneath a costume and can therefore become invisible to the audience if desired by the creative team.

:PERCEPTION + :TACTONS

The suit uses moving sequences or patterns of vibrations called tactons to convey information. Basic tactons can be diversified by varying the speed, intensity, and articulation of each vibrating motor.

Tactons can be the building blocks for a vibration score. The vibrating motors are felt strongly on the body, and it's important for composers using the suit to consider the limitations of vibrotactile perception and cognitive capacity of the musicians. The person wearing the suit can only locate the position of a vibrating motor approximately, and cannot reliably distinguish between slight changes in vibration intesity. Also, while playing, a musician will be focused on sound and expression, not on bodily sensations. In tests, we have determined that a musician can safely distinguish about 15–20 different tactons. Musicians have to practice and learn to 'read' the body:suit:score; it requires a particular expertise analogous to musicians' ability to read a traditional score.

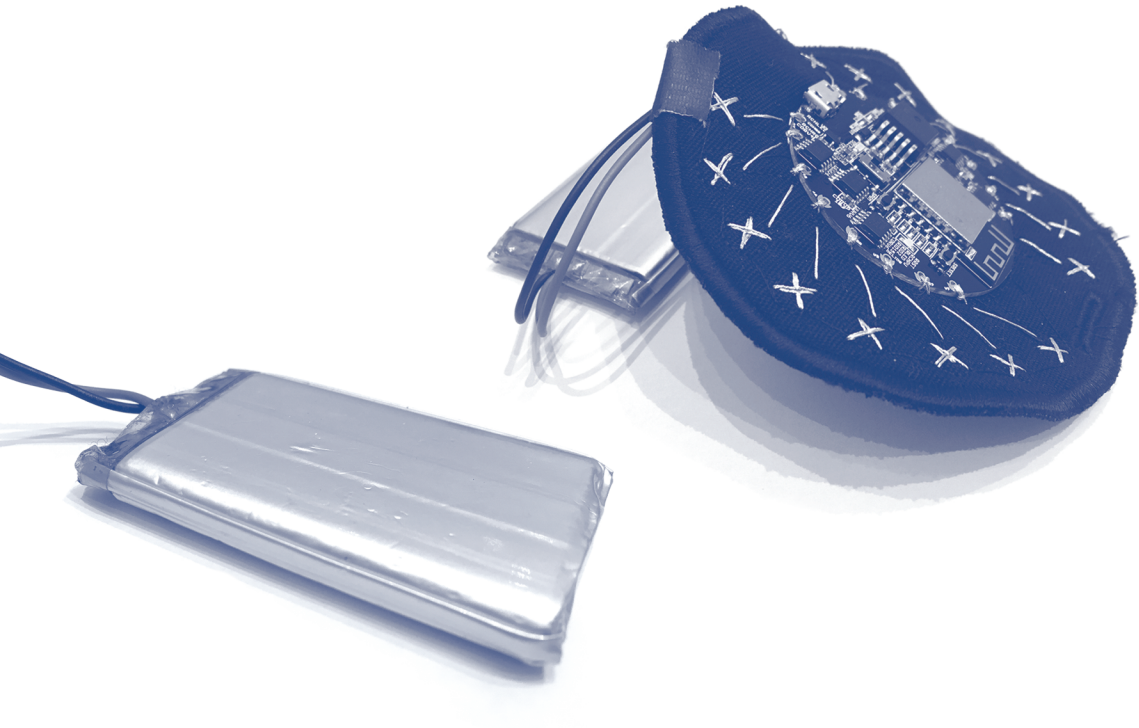


:HARDWARE :SPECIFICATIONS

The vibrating motors used in the suit efficiently generate a strong vibrotactile sensation on the body. The main limitation of these motors is that they increase the intensity of vibration by rotating more quickly, which also affects the frequency of vibration, changing the way the person wearing the suit perceives the sensation.

The purpose of the suit is to allow musicians to wander around freely. This means all commands from the computer conductor must come wirelessly. These messages are sent using UDP packets over a normal wifi network. UDP is optimized for high throughput with low latency—however, it does not guarantee that the suit will receive all information sent from the computer conductor.

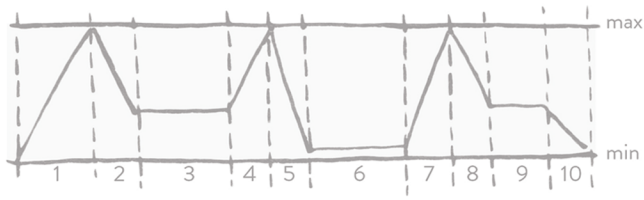
Each full suit has 66 motors. Due to the modular design of the suit, composers can choose to use as many or as few of these motors as needed, taking into consideration the requirements of the composition and the instruments played by the performers.



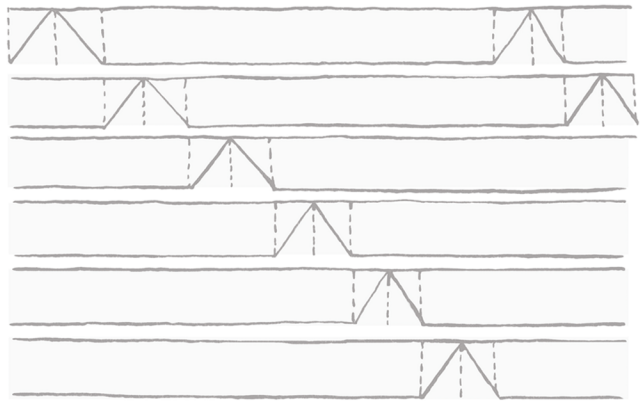
FIRMWARE FEATURES

The firmware allows the amplitude of each motor to be modulated with a 10-stage envelope, as well as an LFO which is designed to facilitate the sensation of a rough texture or regular metronomic pulsations. Metronome pulses can be tightly synchronized across motors, modules, and suits with sub-millisecond precision using the network clock synchronization system. A tacton is established when several motors are triggered in a coordinated sequence.

Example 10 stage envelope



"rotating" tacton using envelope



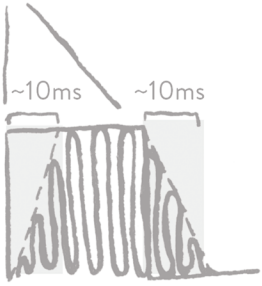
while the MOTOR vibrates at a higher frequency, the LFO modulates it's amplitude at a specific tempo.

metronome LFO
(frequency eg. 2hz / 120 BPM)

texture LFO
(frequency eg. 40hz)

etc.

feels "rough"



actual amplitude change is not instantaneous due to motor inertia

“HOW COULD SUCH MOBILE MUSIC BUILD ON THE RICH HERITAGE AND PRACTICE OF WRITTEN MUSIC—ITS POLYPHONY, ITS WELL-ARTICULATED DRAMATURGY, ITS COORDINATION IN A SPLIT SECOND BETWEEN MANY MUSICIANS?”

:COMPOSING :WITH THE B:S:S

Composers first need to know why their idea would need a bodysuit—most existing music does not need one. Then the composer must decide whether they want to use the bodysuit as an analog score, where musicians (for example) feel the vibration patterns and react to them with music, or as a symbol score, where tactons, metronome pulses, and other functions convey messages to the musicians.

The score, so far, has been used to

- let two spatially separated musicians play with each other by feeling each other's emotions
- let audience members control aspects of the musician's performance through a mobile interface
- prompt the musician to perform score instructions generated in real-time from other data
- steer moving musicians through an invisible trajectory
- let musicians turn towards and away from each other, changing their sonic and musical relationship

Does this give you any ideas for a new music that can only be realized with a body:suit:score?

Contact us at **matra**lab.

:BODY:SUIT:SCORE :TEAM

CURRENT TEAM

Sandeep Bhagwati ---------- Lead Researcher, Artistic Director
Jen Reimer ---------- Project Coordinator

Alexandra Bachmayer ---------- Textiles & Wearable Technology
Travis West ---------- Hardware / Software
Joseph Browne ---------- Software / Audio

BODY:SUIT:SCORE PERFORMERS

Felix Del Tredici ---------- bass trombone
Pietro Amato ---------- french horn
Erla Axelsdóttir ---------- french horn
Elinor Frey ---------- violoncello
Sarah Albu ---------- voice
Elizabeth Millar ---------- clarinet
Nien-Tzu Weng ---------- dance

BODY:SUIT:SCORE COMPOSERS

Adam Basanta
Sandeep Bhagwati
Csenge Kolozsvari
Julian Klein

FORMER TEAM MEMBERS

Julian Stein ---------- Software Development
John Sullivan ---------- Hardware/Software, Haptics Research
Deborah Egloff --------- Hardware/Software, Haptics Research
Marcello Giordano ------ Hardware/Software, Haptics Research
Audrey-Kristel Barbeau ---------- Haptics Research
Sylvain Payen ---------- body:suit:score Learning Games

XS LABS — CONCORDIA

Joanna Berzowska ---------- Textiles & Wearable Technology

INPUT DEVICES AND MUSIC INTERACTION LABORATORY (IDMIL) — MCGILL

Marcelo M. Wanderley ---------- Haptics & Hardware/Software

MUSIC PERFORMANCE AND BODY LAB (MPBL) — MCGILL

Isabelle Cossette ---------- Music Education/Learning