Unlogical instrument: Material-driven gesture-controlled sound installation

ZHEN WU, Hong Kong University of Science and Technology, Hong Kong SAR, China

ZE GAO, Hong Kong University of Science and Technology, Hong Kong SAR, China

TRISTAN BRAUD*, Hong Kong University of Science and Technology, Hong Kong SAR, China

This proposal describes the design and demonstration of the *Unlogical Instrument*. This textile-based gesture-controlled sound interface invites the audience to generate sound by interacting with the textile using different gestures, such as poking, flicking, and patting. *Unlogical* is a statement about breaking the dogmatic approach of commonly used musical instruments. It brings resilience to the form of musical expression and interaction for the audience. It introduces an interactive mechanism mediated by intuitive human gestures and the curiosity to explore tangible material. *Unlogical Instrument* locates the focus on the textile. This artwork investigates the relationship between the gestures and the sound perception that originates from the textile through a material-driven approach. Inkjet printing is applied to transfer the original textile into a sensorial interface. The audience will listen to the sound while interacting with the textile surface, exploring and understanding this instrument through free-form playing.

CCS Concepts: • **Human-centered computing → Interface design prototyping**; **Sound-based input / output**.

Additional Key Words and Phrases: Material-Driven-Design, smart textile, sensorial interaction, musical instruments, gestures, playability.

ACM Reference Format:

Zhen Wu, Ze Gao, and Tristan Braud. 2023. Unlogical instrument: Material-driven gesture-controlled sound installation. In *Designing Interactive Systems Conference (DIS Companion '23), July 10–14, 2023, Pittsburgh, PA, USA.* ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3563703.3596643

1 INTRODUCTION

Material-Driven-Design is an emerging approach for interactive interface design, inspiring researchers and designers to "turn to material" and develop interactive mechanisms based on the material's property instead of assigning predefined functions [5]. Textile is ubiquitous, from clothes and household linen to more advanced applications such as soft circuits. People interact with textiles through gestures such as poking, stretching, and pulling [4]. Researchers have also explored how the tactile sensation of textiles can be associated with sound [6]. The relationship between textile, sound, and gesture inspired us to combine them into an interactive interface in response to the "material turn" described by Robles et al. [7]. This "material turn" emphasizes the need to consider the commonalities between digital and physical materials towards interaction design. To this end, we proposed the *Unlogical Instrument* as a textile-mediated artifact to explore and experiment with gesture-controlled sonic experiences. The *Unlogical Instrument* focuses on gestural interaction evoked by the material property of the chosen textile. It aims to open a new gestural conversation, bringing resilience to making music instead of following the rules of performing musical instruments. The audiences will create sounds in

*Tristan Braud is the corresponding author.

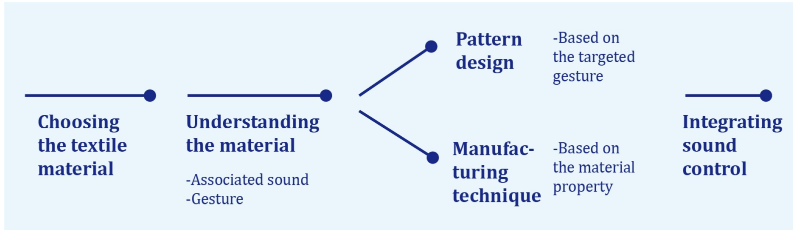

Fig. 1. General approach for developing the prototype following material-driven design Framework.

the installation's area by interacting with the textile using different gestures as they like, generating sounds bonded with the gesture, establishing a material-mediated sound exploration dynamic.

Beyond the art concept described above, our artwork also presents the application of emerging manufacturing technology. Inkjet printing is a less popular interactive textile manufacturing approach than knitting, weaving, and embroidery [8]. We explored this technology in our production process, turning it into a design opportunity for our chosen textile. Through the inkjet-printed conductive patterns on our textile interface, signal changes will correspond to the deformation of the textile as the result of the gestural inputs, triggering different sound effects processed by the computer.

2 RELATED WORKS

Robles and Wiberg [7] stress the necessity of using a textured lens to perceive computation material in the context of HCI research. While the distinction between surfaces and interfaces is becoming hazier along with the new computational technology, it also presents an opportunity to investigate the materiality of interactive surfaces. Moreover, the idea of "qualifying the material not just for what it is, but also for what it does, what it expresses to us, what it evokes from us, what it makes us do" [5] expands this concept to material as a means of expression. Psychologists have also investigated the association between texture and sound. Imschloss and Kuehnl [6] did experiments to evaluate the influence of background music in the retail textile environment. They show that music with high softness enhances users' haptic perceptions of softness. Tag et al. [9] explore the cross-modal correspondence between the haptic and audio for meditation, taking the texture-sound association as inspiration. The association between tactile sensation and sound raised our interest in creating musical instruments that bond the material and the sound they generate.

Textile is a material that offers rich gestural engagement. It is more deformable and sensorial than the hard material used by most modern music devices, such as the MIDI keyboard and joystick controller. Few works have coupled the textiles and musical performance, including the Knitted Keyboard [12], the Tapis Magique [11], the interactive garment for orchestra [3]. The squeeze music ball [10] is one the earliest examples. These works present opportunities to use textiles as music control inputs. However, they do not stress the relationship between the textile deformation and the sounds as outputs. The proposed artwork aims to fill this gap by focusing on the textile-sound association.

3 METHODOLOGY

This project postulates that different textile samples impact sound perception and gestural interactive mechanisms differently. Figure 1 shows our general approach to developing our proposed textile instruments. We started with the choice of material. Then we ran studies to understand the sound association and interactive gesture bonded with this material. Based on the observations, we applied pattern design to the textile for gestural recognition and defined the manufacturing technique to transfer the material into a sensory interface. After producing the interactive textile

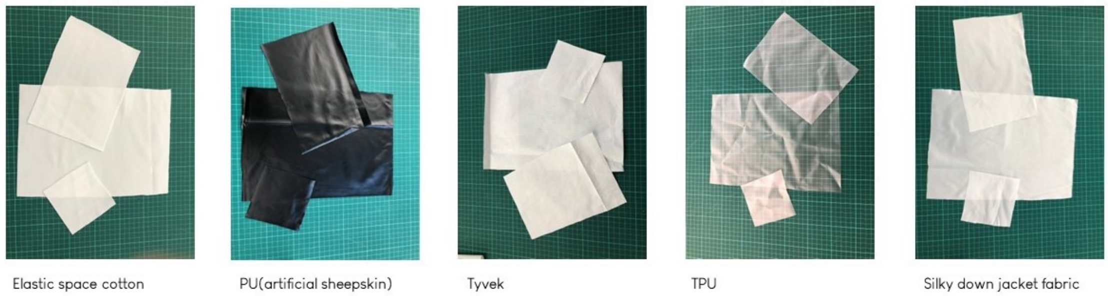

Fig. 2. The five types of textiles utilized in our study.

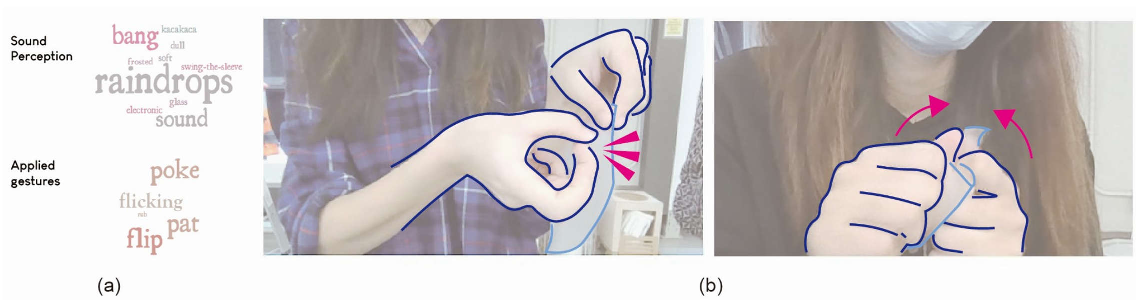

Fig. 3. (a) Result of TPU’s associated sounds and gestures. (b) Participants play with the TPU sample using flicking and flipping.

interface, we connected it with the sound control program (Max/MSP[1] and Processing[2]) on the computer to produce generative music pieces. By placing the material in the center with a research-through-design approach, we expect our design to enrich the understanding of music and sound parameters, creativity, and curiosity during the sound piece creation experience.

4 FORMATIVE STUDY: MATERIAL EXPLORATION

We started our research from a "blank sheet of material", intending to upend the conventional design of musical instruments. We narrowed the target of our material choice to high-density textiles since they are durable and more suitable for experimenting with inkjet printing the conductive ink on their surfaces. We held a workshop encouraging participants to play with five different textiles (see Figure 2) to answer the following research questions:

- (1) What gesture can be used to let the textile produce sound?
- (2) What sound can be associated with this textile?

TPU textile resulted in consistent answers among the user panel and was chosen as the textile for development. Figure 3 demonstrates the answers regarding the sound perceptions and applied gestures associated with this textile. According to our study, the significant gestures are poking, patting, flicking, and flipping, and the material is frequently associated with raindrop sounds and bang beats.

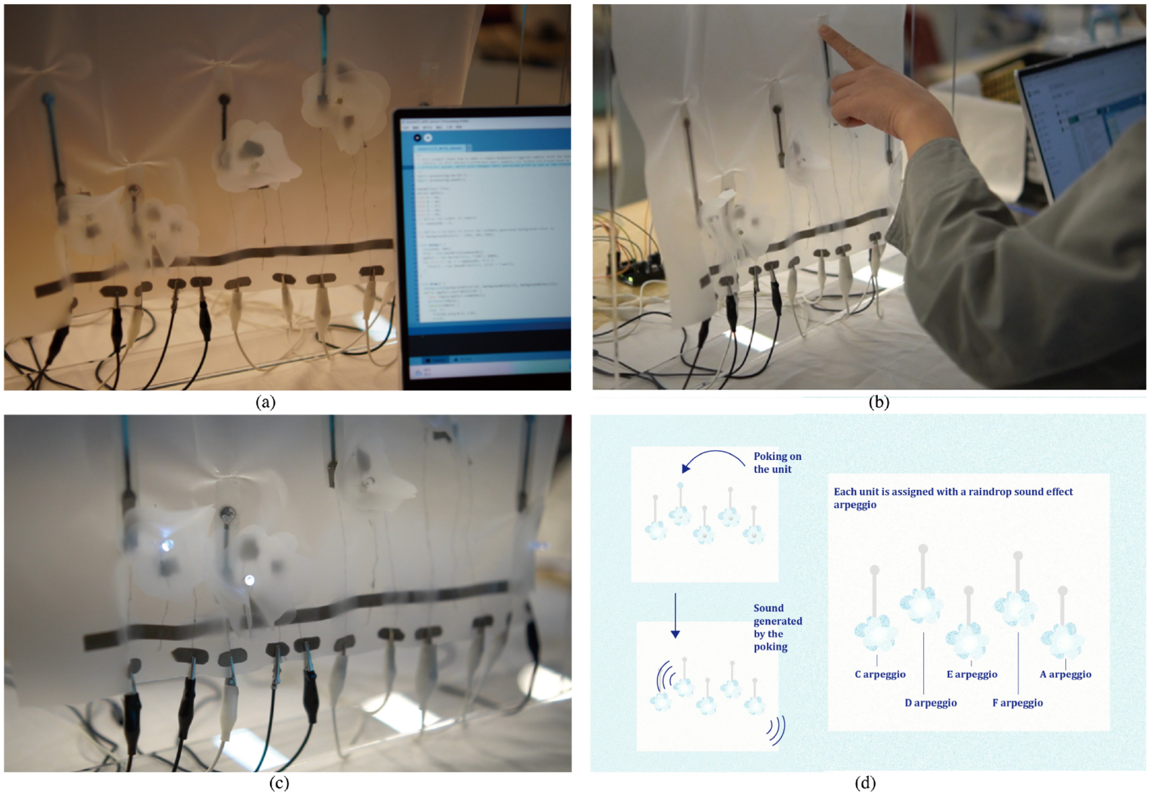

Fig. 4. (a)The prototype setup of the TPU instrument with sensing modules (on the left) and the music processor on the computer (on the right); (b) An audience is poking the sensing units to generate sounds; (c) The units that have been poked light up in sequence; (d) The current interfaces pattern design of the TPU fabric surface.

5 CURRENT PROGRESS-CONCEPT PROTOTYPE

This section describes the project's current development progress. After experimenting with suitable inkjet printing patterns to be reactive to TPU's deformation, we placed five sensing patterns on the TPU surface, inviting the audience to interact with them. Five TPU water flowers were attached with LED lights as visual interaction indicators. Raindrop sound effects in five different arpeggios will be activated from the computer as a sound processor corresponding to audiences' inputs. We demonstrate the progress of our current work in the following video: https://vimeo.com/798689957.

5.1 Pattern design and interaction

Figure 4d demonstrates our pattern design on the TPU surface. There are five sensing units in the shape of simple straight lines. The choice of modular straight lines fits our material surface well and produces noticeable resistant changes when the units deform along with the deformation of the textile. Each unit is assigned a chord in arpeggio pointing to the raindrop sound effect. When the audiences interact with one of the sensor units, causing the textile surface to deform, a LED at the centre of the corresponding water flower will light up, sending a message to the computer to trigger the corresponding arpeggio.

[1]https://cycling74.com/products/max
[2]https://processing.org/

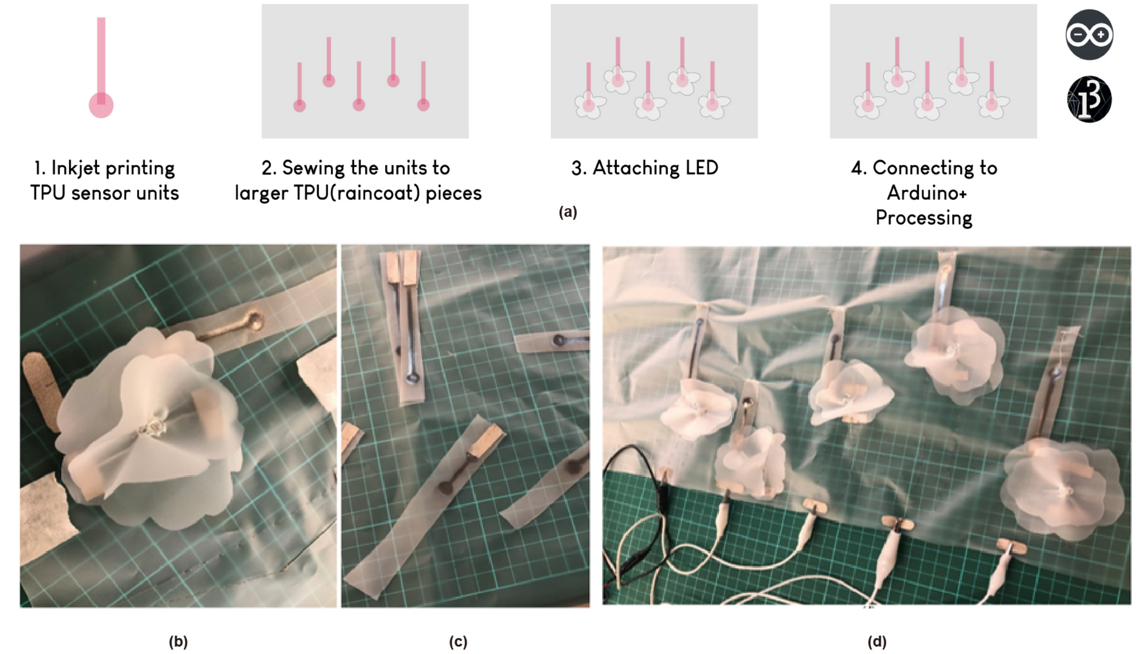

Fig. 5. (a) Flow Chart of the manufacturing process; (b) Water flower units (c) Sensing units that will correspond to deformation; (d) The complete piece of the TPU interactive surface.

5.2 Production and Technical Realisation

Figure 5.a demonstrates the manufacturing process of our interactive textile surface. We first inkjet printed the conductive pattern on the TPU and cut it into separate sensor modules. Then we sewed the unit to the fabric piece and attached the water flower pieces. After that, we connected the circuit followed by building a connection to the computer to process the signal changes by the sensor units using Arduino and Processing[2] to generate the audio. Inkjet printing on textiles is the leading technology we applied in this prototype. This manufacturing approach has two advantages:

- The sensing method can be resilient and flexible, adding another layer of the textile without damaging the textile, especially capable with our TPU fabric.
- Consistent printing patterns can be quickly produced by applying the same pattern in the inkjet printer program.

6 CONCLUSION AND FURTHER WORK

Electronic textiles (e-textiles) have played a significant role in computational audio [8]. Albeit small in numbers, the current literature on the textile-sound association shows promising results. Our current prototype contributes to such a body of work by building the connection between the textile surface and the sound control program. However, it is limited in sound source and specific gestural input. For future work, we will apply a Machine Learning Model to train and specify the gestures the audiences will use to play with the material, then bond the gestures with specific sound effectors. Moreover, the current sound source is arpeggios with sharp piano sounds to create a raindrop atmosphere. For future work, we will apply a more integrated sound design and improve the choice of sound effects. We will also extend the scale of the fabric piece to enable several audiences to play with one textile surface at a time.

[2] https://www.arduino.cc/

7 ARTISTS BIOGRAPHIES

Zhen WU is a Ph.D. student at the Hong Kong University of Science and Technology, Division of Integrative Systems and Design. Her current research interest is playful interaction, sensory interface, and designing Virtual Reality gaming experiences. Before coming to HKUST, Zhen studies Industrial Design focusing on interaction design and Human-Computer-Interaction.

Ze GAO is a New Media Artist, Theorist, and Curator based in Hong Kong and New York. He studied Multidisciplinary Fine Arts at the Maryland Institute College of Art and held an MFA with honors in the School of Visual Arts in New York. Mr. Gao's photography, augmented reality, motion capture performance, and interactive installation have been showcased internationally in China, Japan, Singapore, North America, and Europe. A select sampling of his exhibitions includes the ACM Multimedia art exhibition 2022 in Lisbon[1], ISEA 2022 in Barcelona, ARTeFACTo 2022 in Macau[2], Chinese CHI 2022 Art Gallery (Diamond Award) in Guangzhou, NTU Global Digital Art Prize finalist exhibition in Singapore, 2019 International Art Exhibition in Paris at Vanities Gallery.

Tristan Braud is an Assistant Professor in the Division of Integrative Systems and Design at the Hong Kong University of Science and Technology. He directed the Extended Reality and Immersive Media Lab (XRIM Lab) on Augmented Reality, Virtual Reality, and the Metaverse. He got his Ph.D. from Université Grenoble Alpes, France in 2016. Before that, he was an engineering student at Grenoble INP Phelma/Ensimag, France, and received both an MSC from the Politecnico di Torino, Italy, and Grenoble INP, France. His primary research focus is Augmented and Virtual Reality from system to application and interaction, following a human-centered system design approach.

REFERENCES

[1] Ze Gao, Anqi Wang, Pan Hui, and Tristan Braud. 2022. Meditation in Motion: Interactive Media Art Visualization Based on Ancient Tai Chi Chuan. In *Proceedings of the 30th ACM International Conference on Multimedia*. 7241–7242.

[2] Ze Gao, Xiaolin Zhang, Sijin Zhu, and Tristan Braud. 2022. Metanalysis: A connected-wall video installation based on the movement of traditional Chinese ink painting. In *2022 Third International Conference on Digital Creation in Arts, Media and Technology (ARTeFACTo)*. IEEE, 1–6.

[3] Berit Greinke, Giorgia Petri, Pauline Vierne, Paul Biessmann, Alexandra Börner, Kaspar Schleiser, Emmanuel Baccelli, Claas Krause, Christopher Verworner, and Felix Biessmann. 2021. An Interactive Garment for Orchestra Conducting: IoT-enabled Textile & Machine Learning to Direct Musical Performance. In *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction*. 1–6.

[4] Mengqi Jiang, Vijayakumar Nanjappan, Hai-Ning Liang, and Martijn ten Bhömer. 2022. GesFabri: Exploring Affordances and Experience of Textile Interfaces for Gesture-based Interaction. *Proceedings of the ACM on Human-Computer Interaction* 6, EICS (2022), 1–23.

[5] Elvin Karana, Bahareh Barati, Valentina Rognoli, Anouk Zeeuw Van Der Laan, et al. 2015. Material driven design (MDD): A method to design for material experiences. *International journal of design* 9, 2 (2015), 35–54.

[6] Monika loss and Christina Kuehnl. 2019. Feel the Music! Exploring the Cross-modal Correspondence between Music and Haptic Perceptions of Softness. *Journal of Retailing* 95, 4 (2019), 158–169.

[7] Erica Robles and Mikael Wiberg. 2010. Texturing the "Material Turn" in Interaction Design. In *Proceedings of the Fourth International Conference on Tangible, Embedded, and Embodied Interaction* (Cambridge, Massachusetts, USA) *(TEI '10)*. Association for Computing Machinery, New York, NY, USA, 137–144. https://doi.org/10.1145/1709886.1709911

[8] Rebecca Stewart. 2019. Cords and chords: Exploring the role of e-textiles in computational audio. *Frontiers in ICT* 6 (2019), 2.

[9] Benjamin Tag, Takuya Goto, Kouta Minamizawa, Ryan Mannschreck, Haruna Fushimi, and Kai Kunze. 2017. atmoSphere: mindfulness over haptic-audio cross modal correspondence. In *Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers*. 289–292.

[10] Gili Weinberg, Maggie Orth, and Peter Russo. 2000. The Embroidered Musical Ball: A Squeezable Instrument for Expressive Performance. In *CHI '00 Extended Abstracts on Human Factors in Computing Systems* (The Hague, The Netherlands) *(CHI EA '00)*. Association for Computing Machinery, New York, NY, USA, 283–284. https://doi.org/10.1145/633292.633457

[11] Irmandy Wicaksono, Don Derek Haddad, and Joseph Paradiso. 2022. Tapis Magique: Machine-Knitted Electronic Textile Carpet for Interactive Choreomusical Performance and Immersive Environments. In *Creativity and Cognition* (Venice, Italy). Association for Computing Machinery, New York, NY, USA, 262–274. https://doi.org/10.1145/3527927.3531451

[12] Irmandy Wicaksono and Joseph Paradiso. 2020. KnittedKeyboard: Digital knitting of electronic textile musical controllers. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. 323–326.