

Bioactuated Tapestry: An Installation Exploring Temporalities of Textile Craft and Moisture-Responsive Biomaterials

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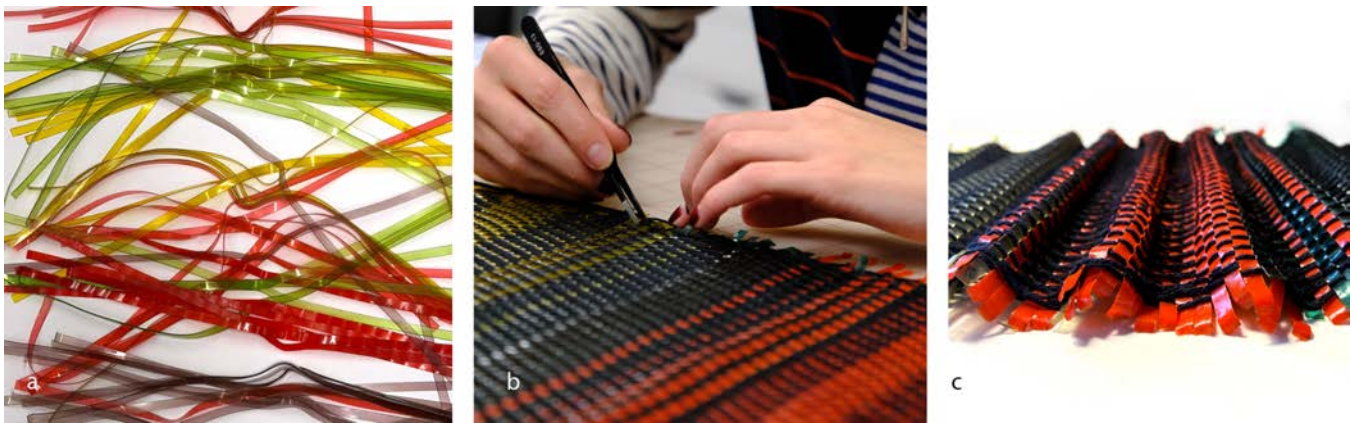


Figure 1: a. Casein-bioplasic laser cut in 5 mm strips; b. Tapestry finishing before bioactuation; c. Profile view of the tapestry after bioactuation triggered by high humidity.

Abstract

Bioactuated Tapestry is an installation that explores how biomaterials and textile craft unfold multiple temporalities of interaction. Structured in three zones, the installation moves from milk-based bioplasic samples that change shape quickly when misted, to a Sample Book that documents iterations of bioplasic integration into weaving, to a woven tapestry that changes shape slowly in response to humidity in the surrounding space. Together, these zones demonstrate how interaction can emerge from material behavior shaped through biomaterial formulation and, when woven, through structure. The work foregrounds biomaterial agency, weaving, and situated sustainability grounded in sourcing, fabrication, and practices of care. Through this convergence of biodesign and textile

craft, *Bioactuated Tapestry* aligns with the TEI theme of Resurgence and Convergence, highlighting how material-led practices reconnect material experimentation, environmental attunement, and embodied ways of knowing.

CCS Concepts

• **Human-centered computing** → *Interaction design*; **Human computer interaction (HCI)**.

Keywords

bioactuation, biomaterials, interactive textiles, material agency, temporality, weaving, sustainability



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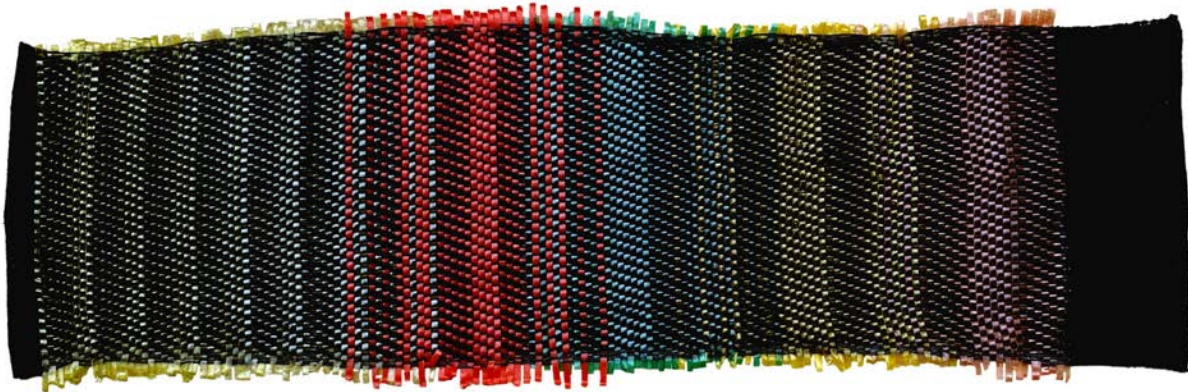


Figure 2: Bioactuated Tapestry woven with casein-based bioplastic in multiple colors on the weft and black cotton on the warp.

1 Concept and Motivation

Building on our earlier exploration of moisture-responsive casein bioplastics in Bioactuated Textiles [10], this installation expands the biomaterial investigations into a spatial setting, where responsiveness is experienced across multiple temporal scales. The tapestry that anchors the installation integrates narrow laser-cut strips of casein bioplastic within a cotton warp (Fig. 1, Fig. 2). As humidity in the surrounding air fluctuates, the bioplastic responds by curling and shifting the textile’s surface in slow, perceptible movements that reveal these subtle changes in moisture levels (Fig. 1c). This gradual unfolding contrasts with the immediacy often expected in interactive systems, inviting reflection on how actuation can occur over extended timescales [4], similar to the subtle movements of plants towards light that unfold too slowly to notice in real time. When the environment becomes dry—or when heat is applied directly to the tapestry (e.g., ironing)—the biomaterial relaxes and flattens again, creating a reversible and cyclical transformation. While the installation includes additional zones that foreground faster forms of responsiveness and the design process that informed the tapestry, the tapestry itself articulates the installation’s slow, ambient temporal register.

The installation’s conceptual grounding draws on craft-based fabrication methods in which material behavior and technique are closely linked [8, 17]. Weaving serves both as structural support and as a means of modulating responsiveness, enabling the humidity-sensitive properties of the casein bioplastic to manifest at the scale of a textile surface. This convergence of biomaterial research and textile craft aligns with ongoing work in interaction design that emphasizes materiality, embodied making, slowness, and environmental awareness as key considerations [16, 19, 21].

Our approach to sustainability in this installation focuses on transformation—rethinking how interaction might emerge from material behavior itself [11, 12, 14, 15, 23]. Here, sustainability is approached as a situated practice grounded in material sourcing, embodied making, and careful attention to how biomaterials interact

with their environments. By leveraging the inherent responsiveness of casein-based bioplastic through its integration into woven structure, the installation foregrounds material-driven interaction not as an aesthetic byproduct but as a generative design orientation.

2 Artistic and Theoretical Context

Bioactuated Tapestry situates itself within material-led design [6, 9], textile craft, and embodied interaction [20]. While shape-changing textiles are often driven by electronic actuation [22], this work foregrounds responsiveness as an intrinsic quality of the biomaterial itself [1, 3, 7, 18]. Within the tapestry, the humidity sensitivity of casein bioplastic becomes the focus of interaction, expressed through the weave. Its slow, reversible shifts draw attention to atmospheric change and to forms of interaction that unfold over extended temporal registers.

Artistically, the installation draws from traditions in textile craft, fiber arts, and material-led design research. These practices treat making as a mode of inquiry, where structure, material, and technique co-produce form and experience. By positioning weaving as a site of experimentation, the work highlights how the structural logics of craft can modulate material behavior and invite perceptual engagement through texture, movement, and light.

Theoretically, the installation extends our earlier explorations of absorption and permeability toward a broader understanding of biomaterial agency and environmental attunement [10]. The tapestry can be activated through direct misting or by proximity to moisture sources, yet its most resonant interaction arises from how it responds within the ambient conditions of the space. This situates responsiveness not as a mechanism of control but as a shared condition between humans, materials, and environment. In this framing, *Bioactuated Tapestry* invites reflection on interaction as coexistence and sensitivity rather than command and feedback.

By connecting textile craft with contemporary biomaterial research and interaction design [2, 24], the installation embodies the TEI theme of Resurgence and Convergence. It contributes to a

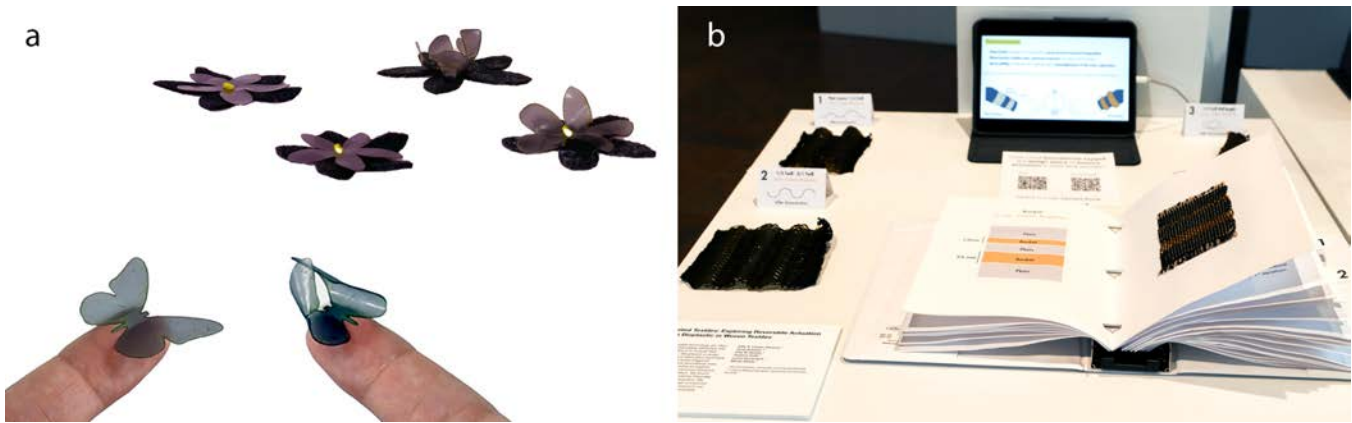


Figure 3: Left: Bioplastic samples the audience can mist with water and interact with; Right: setup of woven samples showing various shape changes in the textile based on material integration and weave structure combinations, and Sample Book.

post-screen paradigm in which technology is experienced through material transformation and embodied perception, foregrounding practices of care, attention, and environmental awareness.

3 Experience and Interpretation

The installation invites visitors to encounter multiple temporalities of responsiveness and to observe how material behavior, textile structure, and environmental conditions shape interaction. These experiences unfold across three zones:

Zone 1: Material Engagement. Visitors handle small casein-based bioplastic samples and mist them with water to observe rapid curling and unfolding (Fig. 3a). This direct interaction offers an immediate understanding of the biomaterial’s responsiveness, revealing a fast temporal register that contrasts with the slow, ambient transformations of the tapestry.

Zone 2: Material–Textile Structure Explorations. In this zone, woven samples combining bioplastic with different textile structures illustrate how responsiveness changes when the material is constrained, supported, or patterned through weaving. A Sample Book (Fig. 3b) documents the iterations that informed the final tapestry, providing a tangible record of the design reasoning, embodied experimentation, and material–structure relationships explored in the process.

Zone 3: Tapestry. The fully woven tapestry (Fig. 2) presents a quiet, slow form of interaction. Subtle shifts in its surface occur as humidity fluctuates, whether through ambient conditions—such as proximity to plants or humidifiers—or through gentle misting. These gradual movements emphasize noticing over immediacy, foregrounding interaction as attunement to environmental change, expanding the ways interaction can be experienced [5, 13]. The bioplastic’s translucency amplifies this experience: when part of the tapestry is positioned over a light box, variations in thickness and weave become visible, revealing layers of craft and material behavior.

Through this arrangement, visitors experience how different temporalities emerge from the interplay of biomaterial properties, textile structure, and environmental conditions. The installation

encourages a shift from rapid, screen-based expectations of interaction toward a slower, more situated mode of engagement—one grounded in the tactile, temporal, and sensorial qualities of crafted biomaterials. In doing so, *Bioactuated Tapestry* frames interactivity as a shared condition between humans, materials, and the surrounding environment, inviting reflection on care, attention, and environmental attunement.

4 Connection to Theme: Resurgence and Convergence

Bioactuated Tapestry aligns with the TEI 2026 Arts & Performance themes of Tangible Resurgence and Interdisciplinary Convergence. The installation contributes to a resurgence of slow, situated, and materially grounded interaction paradigms—highlighting how environmental attunement and gradual material transformation can expand the temporal and sensory repertoire of interactive systems. By centering humidity-responsive biomaterials and the temporal rhythms of their transformations, the work invites visitors to encounter interaction as a process of noticing, care, and embodied attention.

At the same time, the project reflects a convergence across textile craft, biomaterial research, and interaction design. Drawing from fiber arts, material experimentation, and design research, the installation synthesizes these practices into a coherent expressive form. Weaving becomes a site where material behavior, structure, and environmental conditions intersect, demonstrating how crafted techniques can support new modes of interaction and inquiry. Through this integration, *Bioactuated Tapestry* speaks to a broader convergence of disciplines that explore how tangible, environmentally responsive materials can expand the possibilities of interactive systems and embodied experience.

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References

- [1] Fiona Bell, Erin McClure, Camila Friedman-Gerlicz, Ruby Ta, and Leah Buechley. 2024. Shape-Changing Clay-Dough: Taking a Material-Oriented Approach to 3D Printing Ceramic Forms. In *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) (CHI '24). Association for Computing Machinery, New York, NY, USA, Article 864, 19 pages. doi:10.1145/3613904.3642246
- [2] Gabrielle Benabdallah, Eldy S Lazaro Vasquez, Laura Devendorf, and Mirela Alistar. 2025. "Chaotic, Exciting, Impactful": Stories of Material-led Designers in Interdisciplinary Collaboration. In *Proceedings of the 2025 ACM Designing Interactive Systems Conference*. 1313–1327.
- [3] Alice Buso, Holly Mcquillan, Kaspar Jansen, and Elvin Karana. 2024. AnimaTo: Designing a Multimorphic Textile Artefact for Performativity. In *Proceedings of the 2024 ACM Designing Interactive Systems Conference* (Copenhagen, Denmark) (DIS '24). Association for Computing Machinery, New York, NY, USA, 20–34. doi:10.1145/3643834.3660738
- [4] Alastair Fuad-Luke. 2008. Slow Design. In *Design Dictionary: Perspectives on Design Terminology*, Michael Erlhoff and Tim Marshall (Eds.). Birkhäuser Basel, Basel, 361–363. doi:10.1007/978-3-7643-8140-0_251
- [5] Elisa Giaccardi and Johan Redström. 2020. Technology and More-Than-Human Design. *Design Issues* 36, 4 (09 2020), 33–44. doi:10.1162/desi_a_00612
- [6] Phillip Gough, Soojeong Yoo, Martin Tomitsch, and Naseem Ahmadpour. 2021. Applying Bioaffordances through an Inquiry-Based Model: a literature review of interactive biodesign. *International Journal of Human-Computer Interaction* 37, 17 (2021), 1583–1597.
- [7] Sofia Guridi. 2023. Change of skin. <https://sofiaguridi.xyz/change-of-skin>
- [8] Sofia Guridi, Matteo Iannacchero, and Emmi Pouta. 2024. Towards More Sustainable Interactive Textiles: A Literature Review on The Use of Biomaterials for eTextiles.. In *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*. 1–19.
- [9] 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.
- [10] Eldy S. Lazaro Vasquez, Viola Arduini, Etta W Sandry, Srujana Golla, Laura Devendorf, and Mirela Alistar. 2025. Bioactuated Textiles: Exploring Reversible Actuation of Casein Bioplastic in Woven Textiles. In *Companion of the 2025 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp Companion '25)* (Espoo, Finland) (UbiComp Companion '25). ACM, New York, NY, USA, 6 pages. doi:10.1145/3714394.3750704
- [11] Eldy S Lazaro Vasquez, Lily M Gabriel, Mikhaila Friske, Shanel Wu, Sasha De Koninck, Laura Devendorf, and Mirela Alistar. 2023. Designing Dissolving Wearables. In *Adjunct Proceedings of the 2023 ACM International Joint Conference on Pervasive and Ubiquitous Computing & the 2023 ACM International Symposium on Wearable Computing*. 286–290.
- [12] Eldy S. Lazaro Vasquez, Netta Ofer, Shanel Wu, Mary Etta West, Mirela Alistar, and Laura Devendorf. 2022. Exploring Biofoam as a Material for Tangible Interaction. In *Designing Interactive Systems Conference* (Virtual Event, Australia) (DIS '22). Association for Computing Machinery, New York, NY, USA, 1525–1539. doi:10.1145/3532106.3533494
- [13] Szu-Yu (Cyn) Liu, Jen Liu, Kristin Dew, Patrycja Zdzarska, Maya Livio, and Shaowen Bardzell. 2019. Exploring Noticing as Method in Design Research. In *Companion Publication of the 2019 on Designing Interactive Systems Conference 2019 Companion* (San Diego, CA, USA) (DIS '19 Companion). Association for Computing Machinery, New York, NY, USA, 377–380. doi:10.1145/3301019.3319995
- [14] Qiuyu Lu, Semina Yi, Mengtian Gan, Jihong Huang, Xiao Zhang, Yue Yang, Chenyi Shen, and Lining Yao. 2024. Degrade to Function: Towards Eco-friendly Morphing Devices that Function Through Programmed Sequential Degradation. In *Proceedings of the 37th Annual ACM Symposium on User Interface Software and Technology* (Pittsburgh, PA, USA) (UIST '24). Association for Computing Machinery, New York, NY, USA, Article 109, 24 pages. doi:10.1145/3654777.3676464
- [15] Aditi Maheshwari, Fiona Bell, Eric Gallo, Mihai Ibanescu, Emily Robertson, Charlotte Fairless, Francis Logan, Mary Jane Schmuhl, Henry Cheung, Michael Rein, et al. 2025. Self-Cleaning Textiles for Publicly Shared Soft Surfaces: An Accessible and Scalable Photocatalytic Polyester System with Embedded Light-Emitting Diodes. *ACS omega* 10, 4 (2025), 3978–3987.
- [16] William Odom, Siân Lindley, Larissa Pschetz, Vasiliki Tsaknaki, Anna Vallgård, Mikael Wiberg, and Daisy Yoo. 2018. Time, Temporality, and Slowness: Future Directions for Design Research. In *Proceedings of the 2018 ACM Conference Companion Publication on Designing Interactive Systems* (Hong Kong, China) (DIS '18 Companion). Association for Computing Machinery, New York, NY, USA, 383–386. doi:10.1145/3197391.3197392
- [17] Irene Posch and Geraldine Fitzpatrick. 2018. Integrating Textile Materials with Electronic Making: Creating New Tools and Practices. In *Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction* (Stockholm, Sweden) (TEI '18). Association for Computing Machinery, New York, NY, USA, 158–165. doi:10.1145/3173225.3173255
- [18] Michael L. Rivera, Jack Forman, Scott E. Hudson, and Lining Yao. 2020. Hydrogel-Textile Composites: Actuators for Shape-Changing Interfaces. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) (CHI EA '20). Association for Computing Machinery, New York, NY, USA, 1–9. doi:10.1145/3334480.3382788
- [19] Katta Spiel. 2021. The Bodies of TEI – Investigating Norms and Assumptions in the Design of Embodied Interaction. In *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction* (Salzburg, Austria) (TEI '21). Association for Computing Machinery, New York, NY, USA, Article 32, 19 pages. doi:10.1145/3430524.3440651
- [20] Brygg Ullmer, Orit Shaer, Ali Mazalek, and Caroline Hummels. 2022. *Weaving fire into form: Aspirations for tangible and embodied interaction*. Morgan & Claypool.
- [21] Eldy Lazaro Vasquez, Mirela Alistar, and Laura Devendorf. 2025. Temporalities of Biodesigned Artifacts. (2025).
- [22] Yvonne Y. F. Chan Vili. 2007. Investigating Smart Textiles Based on Shape Memory Materials. *Textile Research Journal* 77, 5 (2007), 290–300. doi:10.1177/0040517507078794 arXiv:https://doi.org/10.1177/0040517507078794
- [23] Kathryn Walters, Laura Devendorf, and Karin Landahl. 2024. Animated Linen: Using High-twist Hygromorphic Yarn to Produce Interactive Woven Textiles. In *Proceedings of the 2024 ACM Designing Interactive Systems Conference* (Copenhagen, Denmark) (DIS '24). Association for Computing Machinery, New York, NY, USA, 1177–1191. doi:10.1145/3643834.3662146
- [24] Jingwen Zhu, Fiona Bell, Katherine W Song, Katia Vega, Aditya Shekhar Nittala, Mirela Alistar, Leah Buechley, and Cindy Hsin-Liu Kao. 2025. Wearable Bio-HCI: Challenges & Opportunities. In *Proceedings of the Extended Abstracts of the CHI Conference on Human Factors in Computing Systems*. 1–5.