Designing Interactions with Kombucha SCOBY

Fiona Bell
fiona.bell@colorado.edu
ATLAS Institute
University of Colorado Boulder
Boulder, Colorado, USA

Derrek Chow
derrek.chow@colorado.edu
ATLAS Institute
University of Colorado Boulder
Boulder, Colorado, USA

Eldy S. Lazaro Vasquez
eldy.lazarovasquez@colorado.edu
ATLAS Institute
University of Colorado Boulder
Boulder, Colorado, USA

Laura Devendorf
laura.devendorf@colorado.edu
ATLAS Institute & Info Science
University of Colorado Boulder
Boulder, Colorado, USA

Mirela Alistar
mirela.alistar@colorado.edu
ATLAS Institute & Computer Science
University of Colorado Boulder
Boulder, Colorado, USA

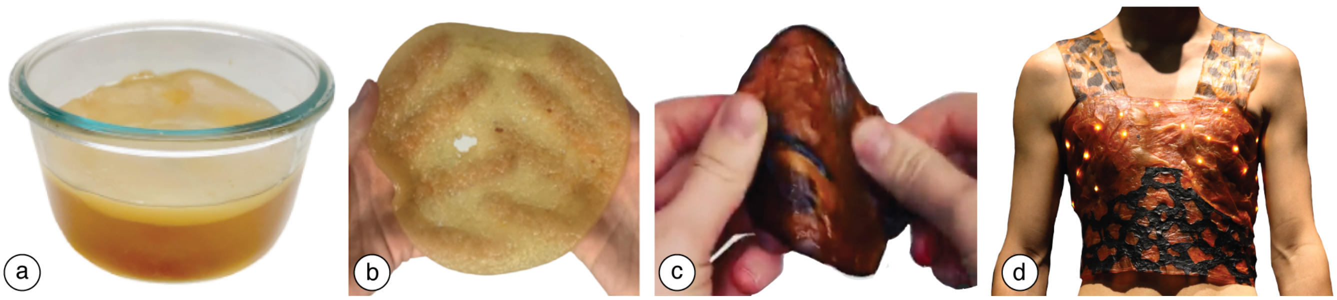

Figure 1: Kombucha SCOBY (Symbiotic Culture of Bacteria and Yeast), is a sustainable cellulose biofilm, (a) grown in kombucha tea, (b) that can be harvested and then dried. (c) Once dry, SCOBY acts similarly to traditional animal and plastic based leathers. (d) This studio aims to facilitate a space to explore how dry SCOBY "leather" can be customized via color, shape and electronics to create wearables and other interactive applications for HCI.

ABSTRACT

The goal of this studio is to facilitate a space in which HCI researchers and designers can explore SCOBY (Symbiotic Culture of Bacteria and Yeast), a sustainable biofilm, grown in kombucha tea, that acts similarly to traditional leathers when harvested and dried. While SCOBY is a popular biomaterial in biodesign and DIYBio practices, we aim to introduce SCOBY as a biomaterial for HCI and ground it in sustainable HCI and slow design theory. Participants will then gain hands-on experience with SCOBY through a material exploration phase (e.i., learning how to embed colors, patterns, and electronics) followed by a structured SCOBY application creation phase. Ultimately, the goal of this studio is to give HCI practitioners who are interested in biodesign a space and time to collaborate, create and discuss the opportunities and challenges of kombucha SCOBY as a biomaterial for HCI.

TEI '23, February 26-March 1, 2023, Warsaw, Poland

ACM ISBN 978-1-4503-9977-7/23/02.
https://doi.org/10.1145/3569009.3571841

CCS CONCEPTS

• **Human-centered computing → Interaction design process and methods.**

KEYWORDS

Bio-HCI; Biodesign; Biomaterials; DIYBio; Microbial Cellulose; Slow Design; Sustainability; Wearables; Tangible Interfaces

ACM Reference Format:
Fiona Bell, Derrek Chow, Eldy S. Lazaro Vasquez, Laura Devendorf, and Mirela Alistar. 2023. Designing Interactions with Kombucha SCOBY. In *TEI '23: Proceedings of the Seventeenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '23), February 26-March 1, 2023, Warsaw, Poland*. ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3569009.3571841

1 INTRODUCTION

Biological Human-Computer Interaction (bio-HCI) has gained attention over the past decade, as a novel field of research that bridges humans, organisms, and computers by integrating biological materials into interfaces [44, 51, 57]. Recently, there have been a number of Bio-HCI works that utilize biologically based materials such as mycelium [22, 66, 67], bioplastic [6], biofoam [42], and bioclay [10] as biodegradable alternatives for traditionally non-biodegradable materials. SCOBY (Symbiotic Culture Of Bacteria and Yeast), a microbial biofilm that forms at the "air-liquid interface" of a sweet tea called Kombucha [40], fits into this growing library of biologically based materials as one that is "leather-like" when dried, circular (can be re-grown from a starter culture indefinitely), and biodegradable (takes 30 days to biodegrade 96% in soil) [8]. SCOBY "leather", popularized by Suzanne Lee [43], has been commonly used in the biodesign and DIYBio communities for fashion [4, 20, 41], which have sparked bio-HCI researchers to correspondingly use SCOBY to create biodegradable wearables [8, 52, 60].

Although bio-HCI is relatively new in HCI, we have noticed that the research community is very interested in learning about new materials, methods, and techniques—given the success of our TEI'22 studio on algae-based bioplastics [7]. As such, we want to continue raising interest in biomaterials within HCI with a half-day (~4 hour) studio, in which participants will explore kombucha SCOBY. SCOBY comes in two main forms: living (wet SCOBY biofilm, Figure 1a/1b) and dead (dry SCOBY "leather", Figure 1c). For this proposed studio, in-person participants will engage with dead/dry SCOBY "leather" samples brought by organizers rather than living SCOBY (live SCOBY takes ~2 weeks to grow and ~2 days to dry). For the virtual participants, we will include instructions for how to grow SCOBY at home on our studio website. By doing so, both in-person and virtual participants can continue engaging with SCOBY after the studio. While participants will not be able to experience the slow growth of SCOBY during the allotted studio time (instead working with dry SCOBY), we still want to address the challenges and opportunities presented by designing at the pace of another organism. Correspondingly, we will encourage participants to discuss how grown biomaterials, especially SCOBY, address slow design [26, 32, 54, 64] and Sustainable Human-Computer Interaction (SHCI) [14, 49, 59, 68].

We will begin the studio with an introduction to SCOBY (what it is and how it is grown, harvested, and dried), followed by presenting our corresponding work on designing SCOBY wearables (teaching our fabrication methods, tools, and techniques) [8, 11]. We will then facilitate an open exploration of SCOBY, in which participants will directly engage with SCOBY samples to get a feel for how it acts and to experiment with different fabrication methods for controlling form (cutting, sewing, and layering), aesthetics (transfer printing and painting), and function (embedding electronics, and adding electrical conductivity). Once participants have gained more confidence working with SCOBY we will task participants with creating a SCOBY wearable either on their own or by following a simple pre-set design that we will guide (see Figure 1d for an example of a SCOBY wearable). We will close our studio with short presentations of the wearables made by participants and a discussion of their experiences designing with SCOBY.

2 BACKGROUND

To reduce the environmental impact of current design practices, researchers have repurposed waste to reduce raw material consumption [10, 19, 70], unmade artifacts to reuse raw materials [14, 63, 71], theorized posthuman design methodologies [18, 53, 55, 61, 69], and developed biodegradable materials [6, 33, 42, 52, 62, 67]. This studio focuses on SCOBY, a biodegradable material that highlights the importance of "linking invention and disposal" [14] when approaching sustainability in HCI [49, 59, 68].

When living, SCOBY has been used as a genetically engineered storage device for memories [1], a genetically engineered fluorescent display [23], a speculative "semi-living" sculpture [15], and a grown "robot" that can encapsulate waterproof electronics [56]. When dead/dry, SCOBY transforms into a sturdy, flexible, and easy-to-work-with biodegradable material that acts like leather. SCOBY has been used for art installations such as Giulini's "Bodypuppets" [24] and Lynch's "Gut Feelings" [48]; for commercial products such as Bucha Bio's Shorai material [12] and Kombucha Biomaterials' paper [13]; for biodesign projects such as "GIY Bio Buddies" [29] and "CocoBucha" [20]; and for fashion such as Lee's BioCouture [43] and Baker's kombucha jacket [4]. Researchers have recently taken inspiration from, SCOBY's use in the fashion world to create wearables, such as ScobyTec's biker jacket that uses colored LEDs to signal the wearer's mood [60] and Ng's "Ava" that can be worn as an accessory [52]. We also acknowledge that there are several Do-It-Yourself Biology (DIYBio) [39] resources and projects for kombucha SCOBY [16, 35, 50, 58, 65]. In this studio, we take inspiration from these past works to teach others how to design their own SCOBY applications.

We further situate this SCOBY studio within the growing biological HCI (Bio-HCI) community, which is interested in utilizing biological materials to create novel interfaces and interactions [31, 44, 51, 57]. Some Bio-HCI work focuses on incorporating living materials such as bacteria [3, 25, 34, 38, 47, 72], green algae [11, 17, 30, 45], bioluminescent algae [5, 55], fungus [27, 32], plants [21, 28, 36, 37] and slime mold [46] to create dynamic interfaces and displays. Other research focuses on using materials derived from once-living organisms such as mycelium [22, 66, 67], bioplastic [6, 33], biofoam [42], and bioclay [10] in combination with electronic components to create more sustainable interfaces. To further bridge biology and HCI, researchers have unpacked the opportunities for bioart and HCI collaborations [2], presented a way to transform an HCI studio into a biosafety laboratory [38], provided a taxonomy of digital tools for biodesign [73], introduced a framework for human-microbe interactions [57], and discussed the implications of living media interfaces [51].

Apart from teaching design and making techniques with SCOBY, our studio also aims to highlight one of the most unique affordances of biological interfaces—slowness. Notable Bio-HCI works that directly address slowness include Mould Rush, which uses the slow growth of fungi and bacteria to create a bio-digital game [32] and Self-deStaining textiles, which record wearer's experiences over time through a slow photocatalytic reaction that degrades organic stains with light [9]. By discussing the time scales of SCOBY during each step in its life cycle (growing, drying, fabricating, biodegrading) we hope to encourage participants to draw connections between slow design, bio-HCI, and SHCI—the slowness of SCOBY encouraging more thoughtful and intentional design decisions [8].

3 STUDIO PROPOSAL

3.1 Learning goals

The aim of this studio is to familiarize participants with kombucha SCOBY via hands-on explorations and to teach them about slow design, bio-HCI, and SHCI. Accordingly, the studio will look into:

- How can SCOBY be utilized by the HCI community? How can SCOBY support the creation of sustainable interactive interfaces?
- What opportunities and challenges does SCOBY present in the context of interaction design? What would the future of HCI look like if researchers start working with materials that are *grown*?
- What roles do slowness and sustainability play when creating tangible interfaces? How can we challenge current making methodologies to make them more sustainable?

3.2 Materials to be explored

To achieve our learning goals, we envision our studio being divided into 4 main stages, taking a total of 4 hours:

(1) Introduction: We will begin by introducing participants to how the studio will run, and to SCOBY. We will cover how to grow SCOBY from scratch using store-bought ingredients, followed by methods for drying SCOBY into a leather-like material (Figure 1a-c). We will also showcase some of our own material explorations with SCOBY and some example applications. Lastly, we will introduce slow design and SHCI and how the two are interconnected.

(2) Open Exploration: During the second stage, participants will engage directly with various dry SCOBY samples to get a feel for how SCOBY behaves. After getting familiarized with SCOBY, we will teach participants different fabrication techniques to control SCOBY's form (cutting, layering, sewing), aesthetics (painting, transfer printing), and function (adding electrical conductivity and electrical components) as seen in Figure 2. Participants will then be allowed to openly explore various methods that we introduced or come up with their own techniques for working with SCOBY.

(3) Structured Making: The third stage of the studio will be devoted to the creation of SCOBY wearables. During this time participants will apply what they learned from their open exploration to create one SCOBY application that is interactive and can be worn (Figure 2). Participants confident working with SCOBY and creating wearables will be allowed to use this time to work on their own. Meanwhile, we will support the more unsure participants by walking them through the creation of a predetermined bracelet wearable. Participants can also optionally work in teams to collaboratively complete this task.

(4) Closing: To close the studio, participants will present their final SCOBY wearables and we will facilitate an open discussion regarding the participants' experiences designing with SCOBY. Example questions that will be posed: Did SCOBY act in expected ways? What were some limitations/ challenges you faced when working with SCOBY? Would you use SCOBY again to make wearables? What future SCOBY experiments/applications do you want to try? Is it important to incorporate sustainable biomaterials into HCI practices? We will end the studio with a summary and closing comments.

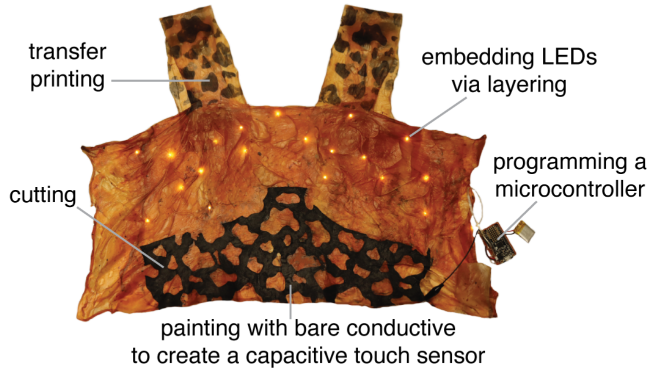

Figure 2: We will begin with an open exploration of SCOBY, in which participants will learn different fabrication techniques (cutting, layering, transfer printing, embedding LEDs, adding electrical conductivity, etc.), and then move to a more structured making activity with SCOBY, in which participants will apply their explorations to make an interactive SCOBY wearable/application.

3.3 Schedule

Our proposed studio is a one-day event planned to span 4 hours with small 10-minute breaks scattered throughout, as seen in Table 1.

Stage	*Duration*	*Description*
1	10 minutes	Introduction to the studio
1	10 minutes	Participant introduction
1	30 minutes	Presentation on SCOBY
	10 minutes	Break
2	15 minutes	Getting familiarized with SCOBY
2	45 minutes	Open design explorations with SCOBY (learn how to integrate electronics and customize color and shape)
	10 minutes	Break
3	45 minutes	Structured making with SCOBY (create interactive SCOBY application)
	10 minutes	Break
4	45 minutes	Present SCOBY accessories and and share experiences with SCOBY
4	10 minutes	Summary and conclusion

Table 1: Day-of Studio Schedule (total time: 4 hours)

3.4 Hybrid/virtual conference

We find that it is easier to collaboratively explore and discuss biomaterials in-person, as such we propose to hold the studio completely in person. However, this studio can also be performed in both hybrid and virtual formats. If in-person, we will provide a wide selection of SCOBY samples, fabrication tools, and additional materials for customization. If hybrid or virtual, online participants will need to obtain their own tools and materials before the studio, which includes growing and drying their own SCOBY samples ahead of time. We note that these materials and tools are typically inexpensive and widely available, i.e., they can be found easily at grocery and craft stores. We will also include a video tutorial and written instructions for how to grow SCOBY on our studio website in December so that virtual participants can make their SCOBY samples ahead of time.

4 SUPPORTING MATERIALS

We plan to create a website for our studio prior to the conference that will have the studio information, call for participation, registration, schedule, important dates, organizers, materials, and instructions. We will update it with information about the format of the studio (in-person, hybrid, or virtual) so that participants know what to expect (e.g., buying their own materials in the case of remote participation). The website will also be a means of disseminating the results of the studio, especially images of various applications made by participants. For recruitment, we will primarily use social media (Instagram and Twitter)—our lab's Instagram account has over 6000 followers, and using it for the TEI'22 studio was very successful. Lastly, we plan to communicate directly with participants via a transparent email chain so that participants can connect and ask questions before and after the studio.

REFERENCES

[1] Mirela Alistar and Margherita Pevere. 2020. Semina Aeternitatis: Using Bacteria for Tangible Interaction with Data. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems.* 1–13.

[2] S Nisa Asgarali-Hoffman and Foad Hamidi. 2021. Perspectives of Bioartists and Community Lab Organizers on Working with Living Organisms. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems.* 1–15.

[3] Christoph Bader, William G Patrick, Dominik Kolb, Stephanie G Hays, Steven Keating, Sunanda Sharma, Daniel Dikovsky, Boris Belocon, James C Weaver, Pamela A Silver, et al. 2016. Grown, printed, and biologically augmented: An additively manufactured microfluidic wearable, functionally templated for synthetic microbes. *3D Printing and Additive Manufacturing* 3, 2 (2016), 79–89.

[4] Jordan Baker. 2018. Kombucha jacket lands HSC student Heather in the London College of Fashion. *The Sydney Morning Harold* (2018).

[5] Bahareh Barati, Elvin Karana, Sylvia Pont, and Tim van Dortmont. 2021. LIVING LIGHT INTERFACES—AN EXPLORATION OF BIOLUMINESCENCE AESTHETICS. In *Designing Interactive Systems Conference 2021.* 1215–1229.

[6] Fiona Bell, Latifa Al-Naimi, Ella McQuaid, and Mirela Alistar. 2022. Designing with Alganyl. In *Proceedings of the Sixteenth International Conference on Tangible, Embedded, and Embodied Interaction.* 1–14.

[7] Fiona Bell and Mirela Alistar. 2022. Designing with Alganyl: A Hands-on Exploration of Biodegradable Plastics. In *Sixteenth International Conference on Tangible, Embedded, and Embodied Interaction.* 1–5.

[8] Fiona Bell, Derrek Chow, Hyelin Choi, and Mirela Alistar. 2023. SCOBY Breastplate: with Alganyl. In *Proceedings of the Seventeenth International Conference on Tangible, Embedded, and Embodied Interaction.* 1–14.

[9] Fiona Bell, Alice Hong, Andreea Danielescu, Aditi Maheshwari, Ben Greenspan, Hiroshi Ishii, Laura Devendorf, and Mirela Alistar. 2021. Self-deStaining Textiles: Designing Interactive Systems with Fabric, Stains and Light. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems.* 1–12.

[10] Fiona Bell, Netta Ofer, and Mirela Alistar. 2022. ReClaym our Compost: Biodegradable Clay for Intimate Making. In *CHI Conference on Human Factors in Computing Systems.* 1–15.

[11] Fiona Bell, Netta Ofer, Ethan Frier, Ella McQuaid, Hyelin Choi, and Mirela Alistar. 2022. Biomaterial Playground: Engaging with Bio-based Materiality. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts.* 1–5.

[12] Bucha Bio. 2022. Shorai. Retrieved December 12, 2022 from https://bucha.bio/

[13] Kombucha Biomaterials. 2022. The Kombucha Paper. Retrieved December 12, 2022 from https://www.kombuchapaper.com/

[14] Eli Blevis. 2007. Sustainable interaction design: invention & disposal, renewal & reuse. In *Proceedings of the SIGCHI conference on Human factors in computing systems.* 503–512.

[15] Oron Catts and Ionat Zurr. 2002. Growing Semi-Living Sculptures: The Tissue Culture Art Project. *Leonardo* 35, 4 (2002), 365–370.

[16] Jasmin Malik Chua. 2015. Grow Your Own Microbial "Leather" in Your Kitchen (DIY Tutorial). Retrieved March 2, 2021 from http://www.ecouterre.com/grow-your-ownmicrobial-leather-in-your-kitchen-diy-tutorial/

[17] Nate J Cira, Alice M Chung, Aleksandra K Denisin, Stefano Rensi, Gabriel N Sanchez, Stephen R Quake, and Ingmar H Riedel-Kruse. 2015. A biotic game design project for integrated life science and engineering education. *PLoS Biol* 13, 3 (2015), e1002110.

[18] Paul Coulton and Joseph Galen Lindley. 2019. More-than human centred design: Considering other things. *The Design Journal* 22, 4 (2019), 463–481.

[19] Kristin N Dew and Daniela K Rosner. 2019. Designing with waste: A situated inquiry into the material excess of making. In *Proceedings of the 2019 on Designing Interactive Systems Conference.* 1307–1319.

[20] Addie Fay, Juan Flores, Cuauhtemoc Martinez Marquez, Penny Medina Sanchez, and Corinne Okada Takara. 2021. CocoBucha. Retrieved April 12, 2022 from https://cocobuchattire.weebly.com/

[21] Owen Noel Newton Fernando, Adrian David Cheok, Tim Merritt, Roshan Lalintha Peiris, Charith Lasantha Fernando, Nimesha Ranasinghe, Inosha Wickrama, Kasun Karunanayaka, Tong Wei Chua, and Christopher Aldo Tandar. 2009. Babbage Cabbage: Empathetic Biological Media. In *Proceedings of the Virtual Reality International Conference: Laval Virtual (VRIC'09).* 20–23.

[22] Çağlar Genç, Emilia Launne, and Jonna Häkkilä. 2022. Interactive Mycelium Composites: Material Exploration on Combining Mushroom with Off-the-shelf Electronic Components. In *Nordic Human-Computer Interaction Conference.* 1–12.

[23] Charlie Gilbert, Tzu-Chieh Tang, Wolfgang Ott, Brandon A Dorr, William M Shaw, George L Sun, Timothy K Lu, and Tom Ellis. 2021. Living materials with programmable functionalities grown from engineered microbial co-cultures. *Nature materials* 20, 5 (2021), 691–700.

[24] Nöle Giulini. 2008. The Bodypuppets. Retrieved December 12, 2022 from http://www.ngiulini.com/portfolio/portfolio/portfolio/bodypuppets.html

[25] Eduard Georges Groutars, Carmen Clarice Risseeuw, Colin Ingham, Raditijo Hamidjaja, Willemijn S Elkhuizen, Sylvia C Pont, and Elvin Karana. 2022. Flavorium: An Exploration of Flavobacteria's Living Aesthetics for Living Color Interfaces. In *CHI Conference on Human Factors in Computing Systems.* 1–19.

[26] Lars Hallnäs and Johan Redström. 2001. Slow technology–designing for reflection. *Personal and ubiquitous computing* 5, 3 (2001), 201–212.

[27] Foad Hamidi and Melanie Baljko. 2017. Engaging children using a digital living media system. In *Proceedings of the 2017 Conference on Designing Interactive Systems.* 711–723.

[28] David Holstius, John Kembel, Amy Hurst, Peng-Hui Wan, and Jodi Forlizzi. 2004. Infotropism: living and robotic plants as interactive displays. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques.* 215–221.

[29] Anne Hu, Trisha Sathish, Emily Takara, and Corinne Okada Takara. 2019. GIY Bio Buddies. Retrieved April 12, 2022 from https://giybiobuddies.weebly.com/

[30] Honesty Kim, Lukas Cyrill Gerber, Daniel Chiu, Seung Ah Lee, Nate J Cira, Sherwin Yuyang Xia, and Ingmar H Riedel-Kruse. 2016. LudusScope: accessible interactive smartphone microscopy for life-science education. *PloS one* 11, 10 (2016), e0162602.

[31] Raphael Kim, Pat Pataranutaporn, Jack Forman, Seung Ah Lee, Ingmar H Riedel-Kruse, Mirela Alistar, Eldy S Lazaro Vasquez, Katia Vega, Roland van Dierendonck, Gilad Gome, et al. 2021. Microbe-HCI: Introduction and Directions for Growth. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems.* 1–4.

[32] Raphael Kim, Siobhan Thomas, Roland van Dierendonck, and Stefan Poslad. 2018. A new mould rush: designing for a slow bio-digital game driven by living microorganisms. In *Proceedings of the 13th International Conference on the Foundations of Digital Games.* 1–9.

[33] Marion Koelle, Madalina Nicolae, Aditya Shekhar Nittala, Marc Teyssier, and Jürgen Steimle. 2022. Prototyping Soft Devices with Interactive Bioplastics. In *Proceedings of the 35th Annual ACM Symposium on User Interface Software and Technology.* 1–16.

[34] David Sun Kong, Keerthi Shetty, Thrasyvoulos Karydis, Yixiao Jiang, Alexandria Guo, Matt Mendoza, Mary Tsang, Shannon Johnson, Ani Liu, Viirj Kan, and Rachel Smith. 2016. Biota Beats. Retrieved May 15, 2021 from www.biotabeats.org

[35] Manuel Kretzer. 2021. Tutorials. Retrieved April 12, 2021 from http://materiability.com/tutorials/

[36] Satoshi Kuribayashi, Yusuke Sakamoto, and Hiroya Tanaka. 2007. I/O plant: a tool kit for designing augmented human-plant interactions. In *CHI'07 extended abstracts on Human factors in computing systems.* 2537–2542.

[37] Satoshi Kuribayashi and Akira Wakita. 2006. PlantDisplay: turning houseplants into ambient display. In *Proceedings of the 2006 ACM SIGCHI international conference on Advances in computer entertainment technology.* 40–es.

[38] Stacey Kuznetsov, Cassandra Barrett, Piyum Fernando, and Kat Fowler. 2018. Antibiotic-responsive bioart: Exploring DIYbio as a design studio practice. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems.* 1–14.

[39] Stacey Kuznetsov, Carrie Doonan, Nathan Wilson, Swarna Mohan, Scott E Hudson, and Eric Paulos. 2015. DIYbio things: open source biology tools as platforms for hybrid knowledge production and scientific participation. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems.* 4065–4068.

[40] D Laavanya, Shivanand Shirkole, and P Balasubramanian. 2021. Current challenges, applications and future perspectives of SCOBY cellulose of Kombucha fermentation. *Journal of Cleaner Production* (2021), 126454.

[41] Sacha Laurin. 2015. Kombucha Couture. Retrieved January 1, 2022 from http://www.kombuchacouture.com/

[42] 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*. 1525–1539.

[43] Suzanne Lee. 2011. Grow your own clothes. Retrieved April 12, 2022 from https://www.ted.com/talks/suzanne_lee_grow_your_own_clothes

[44] SA Lee and IH Riedel-Kruse. 2022. Micro-HBI: Human-Biology Interaction With Living Cells, Viruses, and Molecules. *Front. Comput. Sci. 4: 849887. doi: 10.3389/fcomp* (2022).

[45] Seung Ah Lee, Engin Bumbacher, Alice M Chung, Nate Cira, Byron Walker, Ji Young Park, Barry Starr, Paulo Blikstein, and Ingmar H Riedel-Kruse. 2015. Trap it! A playful human-biology interaction for a museum installation. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. 2593–2602.

[46] Jasmine Lu and Pedro Lopes. 2022. Integrating Living Organisms in Devices to Implement Care-based Interactions. In *Proceedings of the 35th Annual ACM Symposium on User Interface Software and Technology*. 1–13.

[47] Laura Luchtman and Ilfa Siebenhaar. 2018. Living Color. Retrieved May 15, 2021 from https://livingcolour.eu

[48] Alanna Lynch. 2016. Gut Feelings. Retrieved December 12, 2022 from http://alannalynch.com/portfolio/gut-feelings-2017/

[49] Jennifer C Mankoff, Eli Blevis, Alan Borning, Batya Friedman, Susan R Fussell, Jay Hasbrouck, Allison Woodruff, and Phoebe Sengers. 2007. Environmental sustainability and interaction. In *CHI'07 extended abstracts on Human factors in computing systems*. 2121–2124.

[50] Materiom. 2021. Materials Library. Retrieved May 15, 2021 from https://materiom.org/

[51] Timothy Merritt, Foad Hamidi, Mirela Alistar, and Marta DeMenezes. 2020. Living media interfaces: a multi-perspective analysis of biological materials for interaction. *Digital Creativity* 31, 1 (2020), 1–21.

[52] Audrey Ng. 2017. Grown microbial 3D fiber art, Ava: fusion of traditional art with technology. In *Proceedings of the 2017 ACM International Symposium on Wearable Computers*. 209–214.

[53] Charlotte Nordmoen. 2020. Decentring the Human in Digital Making-Towards Embodied Mattering. In *Companion Publication of the 2020 ACM Designing Interactive Systems Conference*. 543–547.

[54] William T Odom, Abigail J Sellen, Richard Banks, David S Kirk, Tim Regan, Mark Selby, Jodi L Forlizzi, and John Zimmerman. 2014. Designing for slowness, anticipation and re-visitation: a long term field study of the photobox. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 1961–1970.

[55] Netta Ofer, Fiona Bell, and Mirela Alistar. 2021. Designing Direct Interactions with Bioluminescent Algae. In *Designing Interactive Systems Conference 2021 (DIS '21)*.

[56] Pat Pataranutaporn, Jaime Sanchez De La Vega, Abhik Chowdhury, Audrey Ng, and Galina Mihaleva. 2018. Toward Growable Robot: Exploring and Integrating Flexible–Biological Matter with Electronics. In *2018 International Flexible Electronics Technology Conference (IFETC)*. IEEE, 1–4.

[57] Pat Pataranutaporn, Angela Vujic, David S Kong, Pattie Maes, and Misha Sra. 2020. Living bits: Opportunities and challenges for integrating living microorganisms in human-computer interaction. In *Proceedings of the Augmented Humans International Conference*. 1–12.

[58] Cecilia Raspanti. 2020. BioFabricating Materials. Retrieved April 12, 2021 from https://class.textile-academy.org/classes/2020-21/week06/

[59] Christian Remy, Oliver Bates, Vanessa Thomas, and Elaine M Huang. 2017. The limits of evaluating sustainability. In *Proceedings of the 2017 Workshop on Computing Within Limits*. 103–110.

[60] Nadja Sayej. 2014. A Smart, Mood-Sensing Jacket Made of Kombucha, Because That's What Bikers Need. Retrieved January 1, 2022 from https://www.vice.com/en/article/9ak3me/a-smart-mood-sensing-jacket-made-of-kombucha-because-thats-what-bikers-need

[61] Nancy Smith, Shaowen Bardzell, and Jeffrey Bardzell. 2017. Designing for cohabitation: Naturecultures, hybrids, and decentering the human in design. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 1714–1725.

[62] Katherine W Song, Aditi Maheshwari, Eric M Gallo, Andreea Danielescu, and Eric Paulos. 2022. Towards Decomposable Interactive Systems: Design of a Backyard-Degradable Wireless Heating Interface. In *CHI Conference on Human Factors in Computing Systems*. 1–12.

[63] Katherine W Song and Eric Paulos. 2021. Unmaking: Enabling and Celebrating the Creative Material of Failure, Destruction, Decay, and Deformation. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–12.

[64] Carolyn Strauss and Alastair Fuad-Luke. 2008. The slow design principles. *Proceedings of the Changing the Change* 14 (2008).

[65] BROD & TAYLOR. 2021. How to Grow a Kombucha Scoby — in just 10-12 Days. Retrieved April 9, 2021 from https://brodandtaylor.com/blogs/recipes/kombucha-scoby/

[66] Eldy S Lazaro Vasquez and Katia Vega. 2019. From plastic to biomaterials: prototyping DIY electronics with mycelium. In *Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers*. 308–311.

[67] Eldy S Lazaro Vasquez and Katia Vega. 2019. Myco-accessories: sustainable wearables with biodegradable materials. In *Proceedings of the 23rd International Symposium on Wearable Computers*. 306–311.

[68] Eldy S Lazaro Vasquez, Hao-Chuan Wang, and Katia Vega. 2020. Introducing the sustainable prototyping life cycle for digital fabrication to designers. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*. 1301–1312.

[69] Ron Wakkary. 2021. *Things we could design: For more than human-centered worlds*. MIT press.

[70] Ludwig Wilhelm Wall, Alec Jacobson, Daniel Vogel, and Oliver Schneider. 2021. Scrappy: Using Scrap Material as Infill to Make Fabrication More Sustainable. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–12.

[71] Shanel Wu and Laura Devendorf. 2020. Unfabricate: Designing Smart Textiles for Disassembly. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–14.

[72] Lining Yao, Jifei Ou, Chin-Yi Cheng, Helene Steiner, Wen Wang, Guanyun Wang, and Hiroshi Ishii. 2015. bioLogic: Natto cells as nanoactuators for shape changing interfaces. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. 1–10.

[73] Jiwei Zhou, Bahareh Barati, Elisa Giaccardi, and Elvin Karana. 2022. Habitabilities of living artefacts: A taxonomy of digital tools for biodesign. *International Journal of Design* 16, 2 (2022), 57–73.