



HAL
open science

Making with Data (and Beyond)

Lora Oehlberg, Samuel Huron, Wesley Willett, Till Nagel, Alice Thudt, Ekene Ijeoma, Dietmar Offenhuber, Eva Hornecker

► **To cite this version:**

Lora Oehlberg, Samuel Huron, Wesley Willett, Till Nagel, Alice Thudt, et al.. Making with Data (and Beyond). CHI '23: CHI Conference on Human Factors in Computing Systems, Apr 2023, Hamburg Allemagne, Germany. pp.1-5, 10.1145/3544549.3583748 . hal-04491332

HAL Id: hal-04491332

<https://hal.science/hal-04491332>

Submitted on 6 Mar 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Making with Data (and Beyond)

Lora Oehlberg
Wesley Willett
lora.oehlberg@ucalgary.ca
wesley.willett@ucalgary.ca
University of Calgary
Calgary, Canada

Samuel Huron
samuel.huron@telecom-paris.fr
Télécom Paris, CNRS i3 (UMR 9217),
Institut Polytechnique de Paris
Palaiseau, France

Till Nagel
Mannheim University of Applied
Science
Mannheim, Germany
t.nagel@hs-mannheim.de

Alice Thudt
Freelance Interface Designer &
Researcher
Dießen am Ammersee, Germany
alice.thudt@gmail.com

Ekene Ijeoma
MIT
Boston, United States
ekene@ekeneijeoma.com

Dietmar Offenhuber
Northeastern University
Boston, United States
d.offenhuber@northeastern.edu

Eva Hornecker
Bauhaus-Universität Weimar
Weimar, Germany
eva.hornecker@uni-weimar.de



Figure 1: A physical representation of data created by a paper artist using a mix of digital design and physical crafting techniques.

ABSTRACT

In this proposed panel, we will discuss the practice of *Making with Data*—the practice of creating physical artifacts that represent a dataset. This topic lies at the intersection of several CHI communities: data visualization, fabrication, and tangible interaction. Our goal is to discuss contemporary practices, but also to envision future ways that we might continue to make physical representations of data in the future, given emerging fabrication techniques, data representation practices, and desired interactions and experiences with data.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).
CHI EA '23, April 23–28, 2023, Hamburg, Germany
© 2023 Copyright held by the owner/author(s).
ACM ISBN 978-1-4503-9422-2/23/04.
<https://doi.org/10.1145/3544549.3583748>

CCS CONCEPTS

• Human-centered computing → Visualization theory, concepts and paradigms; Visualization systems and tools.

KEYWORDS

data physicalization, physical data representation, data sculpture, fabrication, design process

ACM Reference Format:

Lora Oehlberg, Wesley Willett, Samuel Huron, Till Nagel, Alice Thudt, Ekene Ijeoma, Dietmar Offenhuber, and Eva Hornecker. 2023. Making with Data (and Beyond). In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI EA '23)*, April 23–28, 2023, Hamburg, Germany. ACM, New York, NY, USA, 5 pages. <https://doi.org/10.1145/3544549.3583748>

1 INTRODUCTION

Humans have created physical representations of data for thousands of years—often because they served as fundamental ways of recording information. While we have since evolved to graphical

and digital means of representing data, the practice of physically representing data still persists across a breadth of communities—from everyday people to artists, designers, and researchers. The creation of these physical representations of data also relies on radically different creation methods ranging from hand crafting to digital fabrication and even computer-controlled actuation. Others require group participation or even leverage direct inputs from the natural environment.

Within the last 20 years, data and information have become more accessible and pervasive in our daily lives—both the information available about the world around us, as well as situated and embedded ways that data can be woven into the world around us [22]. The Human-Computer Interaction research community in response has investigated physical representations of data from multiple perspectives—as a new medium for information visualization, a motivation for new fabrication tools, and a new way of enabling tangible interactions with data. One approach in research is to examine and question the resulting data physicalization artifacts. However, there have also been increasing research attention on extending the information visualization pipeline [7], surveying fabrication processes [4], and proposing new tools [15] and design paradigm [5] that enable physical representations of data to become a reality. By understanding the diverse ways that contemporary creators are making with data, we can also envision a diverse set of future possibilities.

In this panel, we hope to interrogate the diversity of fabrication techniques in use today, building on a set of 5 categories (handcraft, digital fabrication, actuation, participation, and environmental) identified in our recent work [6]. We will invite senior researchers, artists and designers to comment on the challenges and benefits of these different approaches. We also will invite them to challenge the aforementioned categories, question existing definitions, and propose new vocabulary that extends the space of physical data representations. We expect this discussion will be a platform for outlining a new research agenda for the creation of physical data representation.

2 PANELISTS

The panelists will include a mix of researchers and practitioners who have been involved in the design and development of data physicalization projects or data sculptures, or have reflected on the practices used in this new discipline. The panel will be facilitated by some of the authors of the book *Making With Data* [6].

Dietmar Offenhuber is Associate Professor and Chair of Art + Design at Northeastern University. His research focuses on environmental information and evidence construction, their material/sensory aspects and social implications. He wrote the award-winning monograph *Waste is Information – Infrastructure Legibility and Governance* (MIT Press). His forthcoming monograph at MIT Press examines the idea of *Autographic Data*, which include physical traces and self-inscribing phenomena such as tree rings [10]. He theorizes trace-phenomena as non-symbolic forms of data that play a central role in practices of evidence construction from the sciences to grassroots activism [12]. In the context of data physicalization, designers can use autographic phenomena to make processes such as climate change and environmental pollution experiential.

Alice Thudt is a freelance data visualization designer. She received her PhD in Computational Media Design from the University of Calgary. Her PhD research focused on individual meaning-making with personal data through diverse reflective and expressive practices [16, 17]. As part of her research she explored physicalization and data craft as a means for self-reflection and expression. She has further integrated personal data into her own creative practice as a hobby ceramicist. In her series “Life in Clay”, she created functional everyday objects, decorated with visual patterns based on personal data as mementos of cherished relationships and experiences.

Ekene Ijeoma researches how social, political, and environmental systems affect people and develops sound, video, sculpture, installation, and performance using poetic and computational strategies. Across these various media, his work exposes the systems unjustly affecting people and engages people in communally changing these systems. His data-driven artworks sonify and materialize data on overlooked aspects of sociopolitical systems through cultural artifacts. For example, *Deconstructed Anthems*, a series of compositions, sonify the increasing loss of Black Americans to prisons and jails by repeating the Star-Spangled Banner and removing notes based on incarceration rates. Similarly, *Wage Islands*, a series of sculptures, materializes the increasing costs of housing for poor New Yorkers by submerging a topographic map of the city in a water tank based on housing-to-income ratios. His work has been presented by Bemis Center for Contemporary Art, Contemporary Art Museum of St. Louis, Museum of Contemporary Art Denver, Contemporary Art Museum of Houston, The Kennedy Center, Museum of the City of New York, Neuberger Museum of Art, Storefront for Art and Architecture and Museum of Modern Art among others. He is an Assistant Professor at MIT and the Director of Poetic Justice Group at Media Lab.

Eva Hornecker is a Professor of HCI at the Bauhaus-Universität Weimar. She is one of the initiators of the ACM TEI conference. Her research sits at the intersection of technology, design and social sciences, with a specific interest in the roles of tangibility, materiality, and embodiment, and in human sense-making and collaboration. One of her research interests in the past decade has been the role of data representation modality on user experience and the user experience of data physicalization. She and her group have taught a number of creative project-based courses on data physicalization over the last few years, and reflected on the process of data curation as well on how engaging with physicalization can change our view of what data are [18, 20].

3 PANEL MODERATORS

Lora Oehlberg (online moderator) is one of the authors of *Making with Data*. She is an Associate Professor of Computer Science at the University of Calgary. Her research addresses how technology can better support creativity, collaboration, and curiosity in a range of domains, including interaction design, electronic fashion, improvised digital fabrication, physical data representations, improvised theatre, and healthcare innovation. She leads the Curio Lab, and is one of the faculty leaders of the Interactions Lab, a human-computer interaction research collective. She is currently the director of the Computational Media Design graduate program,

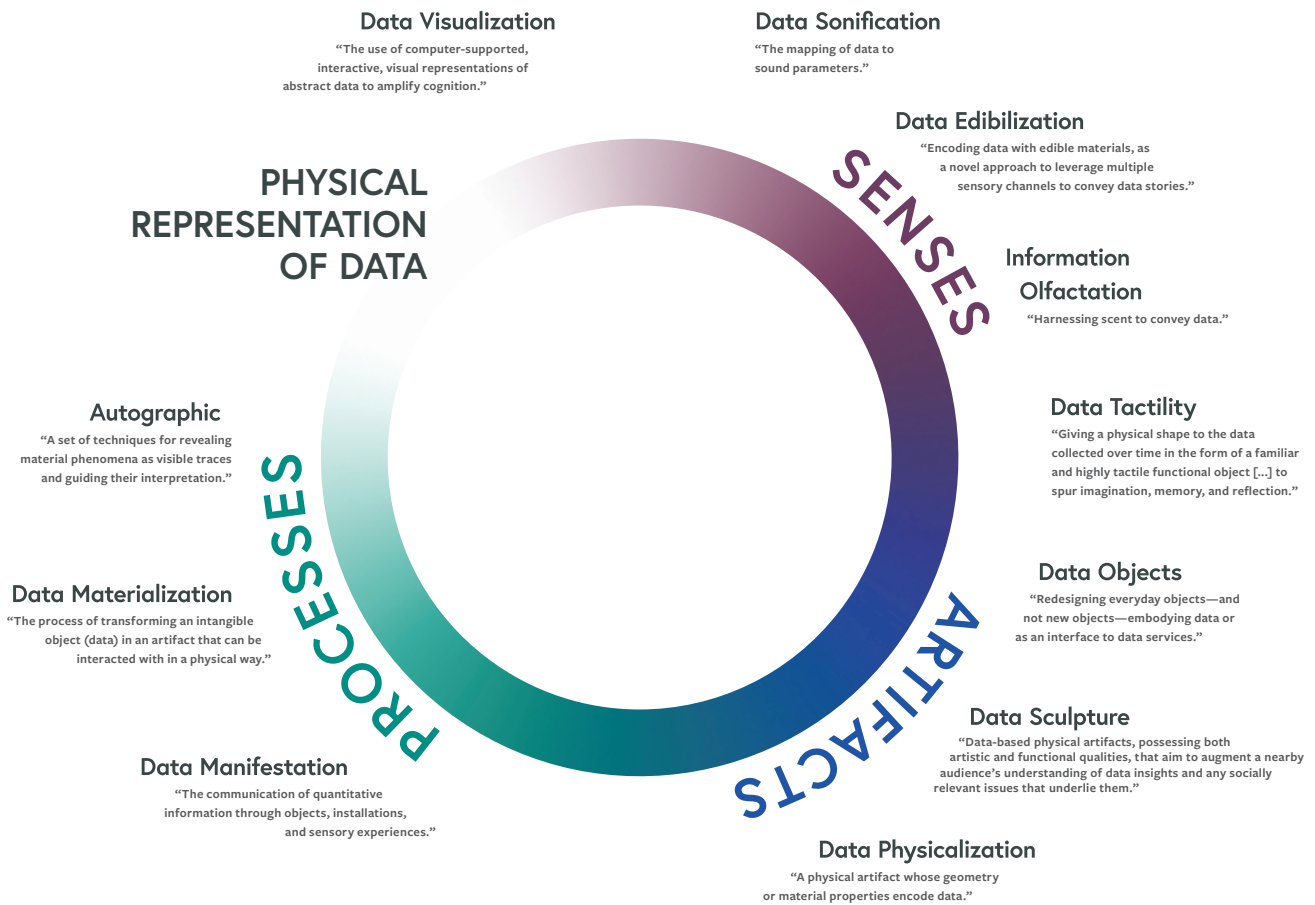


Figure 2: Existing definitions and categories related to the concept of making with data.

and part of the University of Calgary’s Makerspace community of practice group. In 2018 she was awarded a Peak Scholar of Entrepreneurship, Innovation, and Knowledge Engagement from the University of Calgary for her work in “People-Centred Technology for Creativity and Collaboration”. She was an Inria Silicon Valley postdoctoral fellow with the InSitu group at Inria Saclay. She has a PhD and MSc in Mechanical Engineering from the University of California at Berkeley, and a BSc in Mechanical Engineering from Stanford University.

Wesley Willett (online moderator) is one of the authors of *Making with Data*. He is an Associate Professor of Computer Science at the University of Calgary where he holds a Canada Research Chair in Visual Analytics. His interests span information visualization, social computing, new media, and human-computer interaction, and his research focuses on pairing data and interactivity to support collaboration, learning, and discovery. At the UofC, Dr. Willett leads the Data Experience Lab and is a member of the Interactions Lab, the university’s human-computer interaction research collective.

Samuel Huron (in-person moderator) is one of the authors of *Making with Data*. He is an information designer and associate professor in Design of Information Technologies in the Social and

Economical Science department of Télécom Paris at the Institut Polytechnique de Paris, and part of the CNRS Institut Interdisciplinaire de l’Innovation. His research addresses how humans create, visual and physical representations of abstract information to think, collaborate, learn, analyze, explore, and design new data representations, systems and information artefacts. He leads the design studio at Telecom Paris and he is part of the Interact and Diva teams.

Till Nagel (in-person moderator) is one of the authors of *Making with Data*. He is a Research Professor of Visual Analytics at the Mannheim University of Applied Sciences. His interests are in information visualization, interaction design and data literacy. He heads the Human Data Interaction Lab, which investigates new ways of supporting different target groups with interactive data representations. A major focus of his research is around the themes of urban data and mobility visualizations, and in the democratization of visualization tools. He was the general chair of the IEEE VIS Arts Program 2018 and 2019. Dr. Nagel has a background in media and computer science, and received his PhD at the Human Computer Interaction group at KU Leuven. He was a visiting scholar at the MIT Senseable City Lab in Boston and Singapore, a postdoctoral fellow at the FHP Urban Complexity Lab, and a guest professor at

Burg Giebichenstein University of Arts and Design. His work has been exhibited at, among others: Venice Biennale of Architecture, Shanghai Design Exhibition, and UN Habitat X Change.

4 PANEL FORMAT

The panel will include 3 moderators and 4 panelists. The panel—if possible—will be designed as a hybrid event, such that we will use online systems to interact with both the in-person and virtual audience to moderate questions and discussion. Two moderators will be leading the in-person conversation, while one moderator will be dedicated to fostering conversation online and bringing questions and discussion points from the online conversation into the physical conversation.

Before the panel, we will share a list of definitions of different types of data physicalizations (see Figure 2): Data Visualization [2], Data Sonification [9], Data Edibilization [21], Information Olfaction [1], Data Tactility [3], Data Objects [13], Data Sculpture [23], Data Physicalization [8], Data Manifestation [19], Data Materialization [14], and Autographic Visualization [11].

We will also include the list of themes from *Making with Data* [6]: Handcraft, Participation, Digital Fabrication, Actuation, and Environment. We will ask each panelist to focus on one or two case studies—telling the story of how specific data physicalization projects went from conception to final implementation. We will ask each panelist to position the piece(s) in terms of existing definitions, themes, and methods. We will encourage panelists to select case studies that are provocative, introduce questions, and challenge existing definitions and categories.

The panel itself will be organized into several phases, including initial presentations, discussion, audience engagement, and a summary wrap-up.

4.1 Initial Presentations

First, the moderators will present a set of definitions used to describe physical representations of data (see Figure 2), and five themes from *Making with Data* [6]. Next, each panelist will introduce themselves, and be given a few minutes (and two to four slides) to present a case study of a physical representation of data with a compelling story of how it came to be.

4.2 Discussion

The moderators will ask questions to the panelists, including:

- What are the challenges and benefits of each fabrication technique they've mentioned?
- Given the current set of definitions, where do you see opportunities to extend or connect them to each other?
- What types of expertise and literacy are needed to create physical representations of data?
- How do physical representations of data address or exacerbate issues of equity and inclusivity?
- The act of creating a physical representation of data can often lead creators to a deeper experience of that data than their audiences ultimately achieve. Does readability of the final artifact matter? Why or why not?
- What research and design directions related to physicalization could and should be explored in the future?

We will also invite and introduce questions from the local and online audience to the panelists for discussion.

4.3 Interactivity and Audience Engagement

We will set up a participatory physicalization at the entrance of the panel room, and encourage audience members to respond to simple prompts (Has the audience created a physical representation of data themselves? Which keywords describe their research interests? etc.). For remote attendees, we will provide a Miro board with the same prompts, and gather responses digitally. The online moderator will integrate online responses into the on-site data physicalization. Near the end of the panel, the resulting object will be moved to the stage, and both the panelists and audience members will have an opportunity to discuss the responses and reflect on the participatory construction process.

In addition, we plan to foster backchannel engagement from both in-person and remote participants during the panel session. On our open, collaborative Miro board, we will offer audience an opportunity to respond to a set of prompts:

- What fabrication techniques from other domains could be used to render data representations?
- What other graphical visualization techniques could be applied to physical data representation?
- What tangible interaction techniques could be applied to create new data-driven experiences?

We will also encourage audience participation through social media, by asking attendees to share their own experiences and insights on constructing physical data representations using the conference hashtag.

4.4 Wrap-Up

At the end of the panel, the two in-person moderators will have 5 minutes to summarize the comments, ideas, and highlights from the panel to conclude the discussion.

5 CONCLUSION

We believe that our panel will attract attendees at CHI from multiple research areas, particularly information visualization, fabrication, and tangible interaction. The panel will provide a unique opportunity for attendees to learn about the challenges and opportunities of creating physical data representations—with a focus on diverse fabrication and rendering approaches—and to share their own experiences and insights on this topic.

ACKNOWLEDGMENTS

We thank all the book chapters' authors for participating in the book. This work was partially conducted within the Investments for the Future Program (PIA), CONTINUUM (ANR-08-VERS-0005), funded by French National Research Agency (ANR) and the Living Lab 5G project financed by the Banque Publique d'Investissement (BPI). It was also supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) [RGPIN 2016-04540, RGPIN-2021-02492] and the Canada Research Chairs Program.

REFERENCES

- [1] Andrea Batch, Biswaksen Patnaik, Moses Akazue, and Niklas Elmqvist. 2020. Scents and Sensibility: Evaluating Information Olfaction. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3313831.3376733>
- [2] Mackinlay Card. 1999. *Readings in information visualization: using vision to think*. Morgan Kaufmann.
- [3] Audrey Desjardins and Timea Tihanyi. 2019. ListeningCups: A Case of Data Tactility and Data Stories. In *Proceedings of the 2019 Conference on Designing Interactive Systems* (San Diego, CA, USA) (DIS '19). Association for Computing Machinery, New York, NY, USA, 147–160. <https://doi.org/10.1145/3322276.3323694>
- [4] Hessam Djavaherpour, Faramarz F. Samavati, Ali Mahdavi-Amiri, Fatemeh Yazdanbakhsh, Samuel Huron, Richard Levy, Yvonne Jansen, and Lora Oehlberg. 2021. Data to Physicalization: A Survey of the Physical Rendering Process. *Computer Graphics Forum* 40, 3 (2021), 569–598. <https://doi.org/10.1111/cgf.14330>
- [5] Samuel Huron, Sheelagh Carpendale, Alice Thudt, Anthony Tang, and Michael Mauere. 2014. Constructive visualization. In *Proceedings of the 2014 Conference on Designing Interactive Systems*. 433–442.
- [6] Samuel Huron, Till Nagel, Lora Oehlberg, and Wesley Willett. 2023. Making with Data: Physical Design and Craft in a Data-Driven World. (2023).
- [7] Yvonne Jansen and Pierre Dragicevic. 2013. An Interaction Model for Visualizations Beyond The Desktop. *IEEE Transactions on Visualization and Computer Graphics* 19, 12 (2013), 2396–2405. <https://doi.org/10.1109/TVCG.2013.134>
- [8] Yvonne Jansen, Pierre Dragicevic, Petra Isenberg, Jason Alexander, Abhijit Karnik, Johan Kildal, Sriram Subramanian, and Kasper Hornbæk. 2015. Opportunities and Challenges for Data Physicalization. In *Proceedings of the 2015 CHI Conference on Human Factors in Computing Systems* (Seoul, Republic of Korea) (CHI '15). Association for Computing Machinery, New York, NY, USA, 3227–3236. <https://doi.org/10.1145/2702123.2702180>
- [9] T.M. Madhyastha and D.A. Reed. 1995. Data Sonification: Do you See What I Hear? *IEEE Software* 12, 2 (1995), 45–56. <https://doi.org/10.1109/52.368264>
- [10] Dietmar Offenhuber. 2019. Data by Proxy – Material Traces as Autographic Visualizations. *IEEE Transactions on Visualization and Computer Graphics* (2019). <https://doi.org/10/gf649f>
- [11] Dietmar Offenhuber. 2020. Data by Proxy – Material Traces as Autographic Visualizations. *IEEE Transactions on Visualization and Computer Graphics* 26, 1 (2020), 98–108. <https://doi.org/10.1109/TVCG.2019.2934788>
- [12] Dietmar Offenhuber. 2020. What We Talk About When We Talk About Data Physicality. *IEEE Computer Graphics and Applications* 40, 6 (Nov. 2020), 25–37. <https://doi.org/10.1109/MCG.2020.3024146>
- [13] Ricardo Sosa, Victoria Gerrard, Antonio Esparza, Rebeca Torres, Robbie Napper, et al. 2018. Data objects: Design principles for data physicalisation. In *Proceedings of the 2018 International Design Conference*. 1685–1696.
- [14] Courtney Starrett, Susan Reiser, and Tom Pacio. 2018. Data Materialization: A Hybrid Process of Crafting a Teapot. In *ACM SIGGRAPH 2018 Art Gallery* (Vancouver, British Columbia, Canada) (SIGGRAPH '18). Association for Computing Machinery, New York, NY, USA, 381–385. <https://doi.org/10.1145/3202918.3203087>
- [15] Saiganesh Swaminathan, Conglei Shi, Yvonne Jansen, Pierre Dragicevic, Lora Oehlberg, and Jean-Daniel Fekete. 2014. Supporting the Design and Fabrication of Physical Visualizations. In *Proceedings of the 2014 CHI Conference on Human Factors in Computing Systems*, Matt Jones, Philippe A. Palanque, Albrecht Schmidt, and Tovi Grossman (Eds.). ACM, 3845–3854. <https://doi.org/10.1145/2556288.2557310>
- [16] Alice Thudt, Dominikus Baur, Samuel Huron, and Sheelagh Carpendale. 2015. Visual mementos: Reflecting memories with personal data. *IEEE Transactions on Visualization and Computer Graphics* 22, 1 (2015), 369–378.
- [17] Alice Thudt, Uta Hinrichs, Samuel Huron, and Sheelagh Carpendale. 2018. Self-reflection and personal physicalization construction. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–13.
- [18] Rosa van Koningsbruggen, Hannes Waldschütz, and Eva Hornecker. 2022. What is Data? - Exploring the Meaning of Data in Data Physicalisation Teaching. In *Proceedings of the 2022 Conference on Tangible, Embedded, and Embodied Interaction* (Daejeon, Republic of Korea) (TEI '22). Association for Computing Machinery, New York, NY, USA, Article 13, 21 pages. <https://doi.org/10.1145/3490149.3501319>
- [19] Karin von Ompteda. 2019. Data Manifestation: Merging the Human World & Global Climate Change. In *2019 IEEE VIS Arts Program (VISAP)*. IEEE Computer Society, Los Alamitos, CA, USA, 1–8. <https://doi.org/10.1109/VISAP.2019.8900829>
- [20] Hannes Waldschütz and Eva Hornecker. 2020. The Importance of Data Curation for Data Physicalization. In *Companion Publication of the 2020 Conference on Designing Interactive Systems* (Eindhoven, Netherlands) (DIS'20 Companion). Association for Computing Machinery, New York, NY, USA, 293–297. <https://doi.org/10.1145/3393914.3395892>
- [21] Yun Wang, Xiaojuan Ma, Qiong Luo, and Huamin Qu. 2016. Data Edibilization: Representing Data with Food. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (San Jose, California, USA) (CHI EA '16). Association for Computing Machinery, New York, NY, USA, 409–422. <https://doi.org/10.1145/2851581.2892570>
- [22] Wesley Willett, Yvonne Jansen, and Pierre Dragicevic. 2017. Embedded Data Representations. *IEEE Transactions on Visualization and Computer Graphics* 23, 1 (2017), 461–470. <https://doi.org/10.1109/TVCG.2016.2598608>
- [23] Jack Zhao and Andrew Vande Moere. 2008. Embodiment in Data Sculpture: A Model of the Physical Visualization of Information. In *Proceedings of the 2008 International Conference on Digital Interactive Media in Entertainment and Arts* (Athens, Greece) (DIMEA '08). Association for Computing Machinery, New York, NY, USA, 343–350. <https://doi.org/10.1145/1413634.1413696>