S. Sandra Bae

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RESEARCH INTEREST

My research spans across human-computer interaction (HCI), data visualization, and computational fabrication. My research focuses on developing systematic toolkits for interactive physicalizations and exploring how tangible interactions can help people understand complex ideas when analyzing data in its physical form.

Keywords: Human-Computer Interaction, Data Visualization, Computational Fabrication, Tangible Interactions

Last Updated (July 2024)

EDUCATION

2020 - PRESENT **University of Colorado, Boulder**
Ph.D. in Creative Technology & Design
Advisor: Ellen Do, Danielle Szafir, & Michael Rivera | ACME Lab, VisuaLab, & Utility Lab

2018 - 2020 **University of California, Davis**
M.S. in Computer Science
A Visual Analytics Approach to Debugging Cooperative, Multi-Robot Systems' Worldviews
Advisor: Kwan-Liu Ma | ViDi Lab

2014 - 2018 **University of California, Davis**
B.A. in Human-Computer Interaction
Minor in Education

AWARDS AND DISTINCTION

2024 CU Boulder's Special Recognition Award for Partnership for Sustainability (*Coffee Ground Filament*)
2024 APUP Researcher at the National Renewable Energy Laboratory ($230,000)
2023 EECS Rising Star
2023 Best Paper Honorable Mention (IEEE VIS23)
2023 Korean American Scholarship Foundation ($2,000)
2023 Achievement Reward for College Scientists ($7,500)
2023 Rocky Mountain RepRap Festival, Most Functional/Useful, *Sensing Networks*
2023 Rocky Mountain RepRap Festival, Most Innovative, *Coffee Ground Filament*
2022 Achievement Reward for College Scientists ($7,500)
2022 Korean American Scholarship Foundation ($3,000)
2022 David T. Spalding Graduate Teaching Fund Fellowship ($1000)
2021 Korean American Scholarship Foundation ($2,000)
2021 CU Boulder Travel Grant ($500)
2021 CU Boulder Dean's Engineering Travel Grant ($400)
2021 Honorable Mention, IEEE World Haptics Student Design Competition
2021 CRA-WP Grad Cohort for Women
2021 Ada Lovelace Fellow, Open Hardware Summit
2021 Craft Award, ACM TEI Student Design Competition.
2021 Achievement Reward for College Scientists ($6,500)
2019 Richard C. and Joy Dorf Engineering Graduate Fellowship ($1,000)
2019 NASA JPL Master's Thesis Educational Fellow ($30,000)
2018 NSF's Preparing Engineering Graduate Students for the 21st Century Fellow ($10,000).
2018 Honorable Mention Visual Storytelling Award, IEEE Pacific Visualization Symposium.
2017 Beneath (CONNECT EXPO 2017) - Judge's Honorable Mention.
2017 UC Davis Organizational Research Expo.
2017 Better Together - AIGA and IDSA.

RESEARCH EXPERIENCE

WINTER 2024 - PRESENT
National Renewable Energy Lab (NREL) | Golden, CO
Graduate Research Assistant
Research with Kenny Gruchalla and Kristi Potter.
Developing an analytical tangible user interface to manipulate separable shape tensors for aerodynamic design (e.g., wind blades). In collaboration with NIST (Dr. Zachary Grey).

FALL 2020 - PRESENT
University of Colorado, Boulder | Boulder, CO
Graduate Research Assistant & Teaching Assistant
Research with Danielle Albers Szafir, Ellen Yi-Luen Do, and Michael L. Rivera.
Teaching assistant for Daniel Leithinger, Laura Devendorf in ATLAS.

SUMMER 2020
Stanford University | Palo Alto, CA (Remote)
HCI Research Intern
Research with James Landay and Elizabeth Murnane.
Identifying and building family-centered, in-car technology to support collaborative learning.

SUMMER 2019 - SUMMER 2020
NASA Jet Propulsion Lab | Pasadena, CA
University Researcher
Research with Federico Rossi, Scott Davidoff, and Joshua Vander Hook.
Working as a NASA JPL Master's Thesis Fellow to expand Summer 2019's project.

SUMMER 2019
NASA Jet Propulsion Lab | Pasadena, CA
Data Visualization / HCI Research Intern
Research with Hillary Mushkin, Santiago Lambedya, Maggie Hendrie, Scott Davidoff.
Developed a visual analytics systems to analyze scheduling coordination for multi-robot systems

SUMMER 2019 - SPRING 2020
University of California, Davis | Davis, CA
Undergraduate / Graduate Student Research Assistant & Teaching Assistant
Research with Kwan-Liu Ma.
Teaching assistant for Kwan-Liu Ma, Hao-Chuan Wang, and Nina Amenta in Computer Science.

REFEREED PUBLICATIONS

CONDITIONAL ACCEPTANCE

1 R. Sorenson-Graff, **S. S. Bae**, and J. Wirfs-Brock. "Integrating Annotations for Sonifications and Physicalizations". In: St. Pete Beach, Florida, 2024, *Submitted to Proceedings of the IEEE VIS 2024*.

JOURNAL ARTICLES

1 **S. S. Bae**, T. Fujiwara, A. Ynnerman, E. Y.-L. Do, M. Rivera, and D. A. Szafir. "A Computational Design Pipeline to Fabricate Sensing Network Physicalizations". In: *IEEE Transactions on Visualization and Computer Graphics (also proc. IEEE VIS 2023)*. Melboune, Australia, 2023, Acceptance rate: 24.7% (133/539)
⁎ **Best Paper Honorable Mention (Top 5%)**.

2 **S. S. Bae**, R. Vanukuru, R. Yang, P. Gyory, R. Zhou, E. Y.-L. Do, and D. A. Szafir. "Cultivating Visualization Literacy for Children Through Curiosity and Play". In: *IEEE Transactions on Visualization and Computer Graphics (also proc. IEEE VIS 2022)*. 2022, Acceptance rate: 26.5% (122/460).

3 R. Woollands, F. Rossi, T. S. Vaquero, M. S. Net, **S. S. Bae**, V. Bickel, and J. V. Hook. "Maximizing Dust Devil Follow-Up Observations on Mars Using Cubesats and On-board Scheduling". In: *Journal of Astronautical Sciences*. 2022.

CONFERENCE ARTICLES

1 P. Gyory, **S. S. Bae**, R. Yang, E. Y.-L. Do, and C. Zheng. "Marking Material Interactions with Computer Vision". In: *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. Hamburg, Germany, 2023, Acceptance rate: 28.39% (880/3182).

2 M. Rivera, **S. S. Bae**, and S. Hudson. "Exploring Spent Coffee Grounds as a Sustainable Material for Prototyping with 3D Printing". In: *Proceedings of the 2023 on Designing Interactive Systems Conference*. Pittsburg, PA, USA, 2023, Acceptance rate: 24.1% (174/726).

3 **S. S. Bae**, D. A. Szafir, and E. Y.-L. Do. "Exploring the Benefits and Challenges of Data Physicalization". In: *Proceedings of the Fourth European Tangible Interaction Studio (ETIS' 22)*. 2022, Acceptance rate: 88% (5/17).

4 **S. S. Bae**, C. Zheng, M. E. West, E. Y.-L. Do, S. Huron, and D. A. Szafir. "Making Data Tangible: A Cross-disciplinary Design Space for Data Physicalization". In: *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*. New Orleans, Louisana, 2022, Acceptance rate: 23% (4590/19964).

5 **S. S. Bae**, F. Rossi, J. V. Hook, S. Davidoff, and K.-L. Ma. "A Visual Analytics Approach to Debugging Cooperative, Autonomous Multi-Robot Systems' Worldviews". In: *Proceedings of the IEEE Visual Analytics Science and Technology (VAST) 2020*. Salt Lake City, Utah (Virtual), 2020, Acceptance rate: 24.8% (52/210).

6 **S. S. Bae***, O.-H. Kwon*, S. Chandrasegaran, and K.-L. Ma. "Spinneret: Aiding Creative Ideation through Non-Obvious Concept Associations". In: *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. Honolulu, Hawaii (Virtual), 2020, (*equally contributed), Acceptance rate: 24.31% (760/3126).

POSTERS & DEMOS

1 **S. S. Bae**, T. Fujiwara, D. A. Szafir, E. Y.-L. Do, and M. L. Rivera. "3D printed multi-point capacitive touch sensor". In: *Symposium on Computational Fabrication*. SCF '24. Aarhus, Denmark: Association for Computing Machinery, 2024.

2 E. Johnson, **S. S. Bae**, and E. Y.-L. Do. "Supporting Data Visualization Literacy through Embodied Interactions". In: *Proceedings of the Fifteenth International Conference on Creativity & Cognition (C&C '22)*. Gathertown (Remote): Association for Computing Machinery, 2023.

3 **S. S. Bae**. "Towards a Deeper Understanding of Data and Materiality". In: *Proceedings of the Fourteenth International Conference on Creativity & Cognition (C&C '22)*. Venice, Italy: Association for Computing Machinery, 2022.

4 **S. S. Bae**, R. Yang, P. Gyory, J. Uhr, D. A. Szafir, and E. Y.-L. Do. "Touching Information with DIY Paper Charts & AR Markers". In: *Interaction Design and Children*. IDC '21. Athens, Greece (Virtual): Association for Computing Machinery, 2021, Acceptance rate: 27% (136/501).

5 **S. S. Bae*** and M. E. West*. "Cyborg Crafts: Second SKIN (Soft Keen INteraction)". In: *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '21)*. Salzburg, Austria (Virtual): Association for Computing Machinery, 2021, (*equally contributed).

TECH REPORTS

1 R. Woollands, F. Rossi, T. S. Vaquero, M. S. Net, **S. S. Bae**, V. Bickel, and J. V. Hook. "Maximizing Dust Devil Follow-Up Observations on Mars Using Cubesats and On-board Scheduling". In: *Proceedings of the 43rd Annual AAS Guidance & Control Conference, Breckenridge, CO*. 2021.

BOOK CHAPTERS

1 T. Hopkins, **S. S. Bae**, J. Uhr, C. Zheng, A. Bani , and E. Y.-L. Do. "User Interfaces in Smart Cities". In: *Handbook of Smart Cities*. Ed. by J. C. Augusto. Springer International Publishing, 2021.

FUNDING (Total $561K)

**co-authored to funded grants*

Human-Computer Interaction Techniques for Large-Scale Data Analysis*
Amount: $231,000
Agency: Alliance Partner University Program (APUP) with National Renewable Energy Laboratory (NREL)
Principal Investigator: Michael L. Rivera, CU Boulder
Co-Principal Investigator: Kenny Gruchulla, NREL
Duration: Jan 2024 - May 2025

Supporting Explainable AI for Future Analysts with Interactive Physicalizations*
Amount: $30,000
Agency: CU Boulder Seed Grant (Engineering Education and AI-Augmented IRT)
Principal Investigator: Michael L. Rivera, CU Boulder
Co-Principal Investigator: Ellen Yi-Luen Do, CU Boulder
External Co-Principal Investigator: Danielle Albers Szafir, UNC-Chapel Hill
Duration: Sept 2023 - Dec 2023

EAGER: Home-Based DIY Interactive Information Physicalization for Young Children and their Parents*
Amount: $300,000
Agency: National Science Foundation
Principal Investigator: Ellen Yi-Luen Do, CU Boulder
Co-Principal Investigator: Danielle Albers Szafir, CU Boulder
Duration: Oct 2020 - Sep 2022

PATENTS

NON-PROVISIONAL PATENT APPLICATION

Bae, S. S, Fujiwara, T., Rivera, M.L., Szafir, D.A., Do., E.Y.D (2023). Systems and Methods for Touching Sensing Based on Resistor-Capacitor Delays. *U.S. Patent Application 63/497,594*, filed April 21, 2023. Pending non-provisional patent application.

TALKS

All first-author conference papers listed above were also given as presentations at their respective conferences and are not listed again in this section.

INVITED GUEST LECTURER

Expanding your Interactive Toolkit: Computer Vision Markers and 3D Printed Capacitive Sensors
Georgia Tech, *Prototyping Interactive Systems*, November 7, 2023 (hosted by Hyunjoo Oh)

Using Computational Fabrication for Data Physicalization
UNC-Chapel Hill, *Information Professionals in the Makerspace*, October 17, 2023 (hosted by Maggie Melo)

Computational Fabrication for Electronics
CU Boulder, *Computational Fabrication*, October 16, 2023 (hosted by Michael L. Rivera)

The Value of Design: Empowering Humans through Human-Centered Thinking
CU Boulder, *Information Visualization*, March 18, 2021 (hosted by Danielle Szafir)

The Value of Design: Empowering Humans through Human-Centered Thinking
UC Davis, *Android Development*, January 14, 2021 (hosted by Nina Amenta)

INVITED TALKS

Pushing Visualizations Beyond the Desktop with Everyday Devices and Novel Interfaces
University of Iowa, November 17, 2023 (hosted by Juan Pablo Hourcade)

Pushing Visualizations Beyond the Desktop with Everyday Devices and Novel Interfaces
Emory University, November 8, 2023 (hosted by Emily Wall)

Pushing Visualizations Beyond the Desktop with Everyday Devices and Novel Interfaces
Georgia Tech, November 8, 2023 (hosted by Yalong Yang)

Using Network Science to Reimagine Everyday Objects as Future Computers
TTI Vanguard, September 13, 2023 (hosted by Nancy Kleinrock)

Towards "Best of Both Worlds": Bridging Digital and Physical Representations in Visualization Research
Linköping University, January 9, 2023 (hosted by Miriah Meyer)

Debugging Multi-Robot Autonomous System Anomalies
CU Boulder ATLAS Seminar, October 6, 2020 (hosted by Ellen Yi-Luen Do)

Debugging Multi-Robot Autonomous System Anomalies
NASA-JPL, August 27, 2020 (hosted by Scott Davidoff)

TEACHING AND MENTORING

TEACHING EXPERIENCE

** indicates the instructor of the course*

Term	Institute	Subject Title	Role	Enrolled	Evals
SUMMER 2024	MIT	Web Development (Brave Behind Bars[1])	Teaching assistance	54	No
SPRING 2022	CU Boulder	ATLAS3300: Object (Physical Computing)	Teaching assistance Laura Devendorf*	37	No
SPRING 2021	CU Boulder	ATLAS3300: Object (Physical Computing)	Teaching assistance Daniel Leithinger*	36	No
SPRING 2020	UC Davis	ECS162: Web Programming	Teaching assistance Nina Amenta*	122	Yes
WINTER 2020	UC Davis	ECS164: Intro to Human-Computer Interaction	Teaching assistance Hao-Chuan Wang*	59	Yes
WINTER 2019	UC Davis	ECS164: Intro to Human-Computer Interaction	Teaching assistance Hao-Chuan Wang*	63	Yes
SUMMER 2018	UC Davis	ECS163: Information Visualization	Teaching assistance Kwan-Liu Ma*	23	No

[1]Brave Behind Bars is a college-accredited introductory computer science and career-readiness program for incarcerated people. https://bravebehindbars.org/

MENTORING

Name	Degree	Project Description	Year
Ada Zhao	M.S. in CTD (CU Boulder)	Capacitive Sensing VR Controller	2024
Carson Kohlbrenner	B.S. in Aerospace Engineering (CU Boulder)	Robotic Skin	2023-2024
Noah Liska	B.S. in Computer Science (CU Boulder)	Robotic Skin	2023-2024
Caleb Kumar	B.S. in Computer Science (CU Boulder)	Robotic Skin	2023-2024
Rhys Sorenson-Graff	B.A. in Computer Science (Whitman College)	Annotation Methods for Physicalizations and Sonifications	2023-2024
Eloise Yalovitser	B.F.A. in Design and Technology (Parson School of Design)	Fabricating multi-touch capacitive sensors	2023
Antonio (Zhixing) Li	B.S. in Mech. Engineering (CU Boulder)	CU Boulder SPUR (Sustainable Nudging)	2023
Elise Johnson	B.S. in Mech. Engineering (CU Boulder)	Discovery Learning Apprenticeship (EAGER project)	2022
Vy Thai	B.S. in Comp. Science (Stanford University)	Design probes for family-centered, in-car technology	2020
Ashleigh Thomas	M.S. in Comp. Science (UC Davis)	N/A (Graduate mentor through CS department)	2019
Lovpret Kaur	B.S. in Comp. Science (UC Davis)	N/A (Undergraduate mentor through UC Davis' Women in Computer Science (WiCS))	2019

ACADEMIC SERVICE

Program Committee
ACM Creativity & Cognition 2021
ACM Tangible and Embedded Interaction (TEI) 2024

Organizing Committee
IEEE VIS 2022, 2024 BELIV Workshop (Social Media and Web Chair)

Invited Conference Reviewer
ACM Symposium on User Interface Software and Technology (UIST) 2021
ACM Interaction Design and Children (IDC) 2023
ACM Designing Interactive Systems (DIS) 2021–2024
ACM Conference on Human Factors in Computing Systems (CHI) 2021–2024
ACM Tangible and Embedded Interaction (TEI) 2022–2024
ACM Creative & Cognition (CC) 2021–2022
EG/VGTC EuroVis 2022
NordicCHI 2024
SIGGRAPH Asia 2024

Invited Journal Reviewer
IEEE Transactions on Visualization and Computer Graphics (TVCG) 2022–2024
International Journal of Child-Computer Interaction 2022
Behaviour & Information Technology 2023
IS&T Journal of Perceptual Imaging 2024

Invited Book Chapter Reviewer
"Visualization Psychology" published by Springer Nature. Editors: Danielle Albers Szafir, Rita Borgo, Min Chen, Darren J. Edwards, Brian Fisher, & Lace Padilla

Special Recognition as a Reviewer
2023 ACM Tangible and Embedded Interaction (TEI)
2023 ACM Conference on Human Factors in Computing Systems (CHI) x2
2024 ACM Conference on Human Factors in Computing Systems (CHI) x2

Institutional Service
Ph.D. Open House Organizer 2021, ATLAS Institute, CU Boulder
Faculty Candidate Student Host 2021, 2024 ATLAS Institute, CU Boulder
Ph.D. Graduate Application Support Program Founder 2022, 2023, ATLAS Institute, CU Boulder

Tutoring
Coding tutor, Women's Resources and Research Center UC Davis, UC Davis (2016-2018)

DESIGN EXHIBITIONS

2019 **Sit On Data** | Imagining America's 20th Anniversary National Gathering
A data-driven parametric-bench where users can feel the data by sitting. Developing using Python, CNC routing, Laser cutting.

2017 **BENEATH** | SOFA Chicago 2017
An immersive installation conveying California's land subsidence. Presented at SOFA Chicago 2017. Built motion graphics and projection using Processing.

2017 **OneClimate: Prototyping Climate Change** | Exploratorium Musem (SF)
A multisensory exhibition conveying the impact of climate change sponsored by the John Muir Institute of the Environment. Featured at the Exploratorium in San Francisco for the OneClimate event, AIGA & ISAD - San Francisco, and IA's 2017 National Gathering. Designed the scientic narrative and constructed the exhibit using woodshop skills.

SELECTED MEDIA COVERAGE

2023 **Yahoo Finance** | First-of-its-kind study combines common household waste product with 3D printing — here are the results
https://finance.yahoo.com/news/first-kind-study-combines-common

2023 **Ars Technica** | Don't throw out those used coffee grounds—use them for 3D printing instead
https://arstechnica.com/science/2023/09/dont-throw-out-those-used-coffee-grounds-use-them-for-3d-printing-instead/

2023 **TechBriefs** | Using Coffee to Reduce Waste from 3D Printing
https://www.techbriefs.com/component/content/article/tb/stories/blog/49103

2023 **Daily camera (Boulder)** | CU Boulder professor creates 3D printing paste with coffee grounds
https://www.dailycamera.com/2023/09/20/cu-boulder-professor-creates-3d-printing-paste-with-coffee-grounds/

2023 **CNC Kitchen (Youtube)** | 3D Printing Resistors, Fibers & Coffee - Utility Research Lab
https://youtu.be/Oeqvo2c28_c

2023 **Make Magazine** | Rocky Mountain RepRap Fest: All The Cool 3D Printing Stuff
https://makezine.com/article/digital-fabrication/3d-printing-workshop/3d-printing-festival-loveland-colorado/

2023 **Meltzone Podcast** | Rocky Mountain RepRap Festival & Prusa MK4
https://youtu.be/NkgOXFn55cM?t=1041

2023 **CU Boulder** | ATLAS Innovators Win Big at RepRap Festival
https://www.colorado.edu/atlas/2023/05/08/atlas-innovators-win-big-reprap-festival

2023 **CU Boulder** | New seed grants from the Engineering Education and AI-Augmented Learning research theme will support range of topics
https://www.colorado.edu/irt/engineering-education-ai/2023/05/19/new-seed-grants-engineering-education-and-ai-augmented-learning-research-theme-will

2021 **CU Boulder** | Sandra Bae receives ARCS and KASF scholarship
https://www.colorado.edu/atlas/2021/09/08/sandra-bae-receives-arcs-and-kasf-scholarships

2017 **CONNECT EXPO** | SOFA CHICAGO 2017 Exhibition
Printing Press: Chubb (pg. 10-11).

2017 **AIGA and IDSA** | Better Together Design Exhibition
Printing Press: AIGA (pg. 8-9).

2017 **UC Davis** | 'OneClimate' a Call to Arms
https://www.ucdavis.edu/news/oneclimate-call-arms