



# (W)E-waste: Creative Making with Rescued Computing Devices

Jasmine Lu  
jasminelu@uchicago.edu  
University of Chicago  
Chicago, IL, USA

Ilan Mandel  
im334@cornell.edu  
Cornell Tech  
New York, NY, USA

Wendy Ju  
wendyju@cornell.edu  
Cornell Tech  
New York, NY, USA

Pedro Lopes  
pedrolopes@uchicago.edu  
University of Chicago  
Chicago, IL, USA

## ABSTRACT

Computing devices become waste for a variety of reasons. They breakdown, become obsolete, or are no longer trendy. These events are so common that currently, e-waste has become the largest consumer waste stream in the world. However, taking apart e-waste devices reveals how they often contain many useful parts and components that could be scrapped and creatively integrated into new forms. These include highly expressive materials like sensors, displays, micro-controllers, etc. This workshop will explore processes in creative making with e-waste, examining the unique materiality of e-waste and how its reuse differs and/or converges with other material reuse processes. To do so, our workshop will combine hands-on activities (tear downs, rapid prototyping, and tutorials) with discussion of the challenges and opportunities in this space. We aim to use these activities to explore how HCI can better support the creative acts of making with e-waste across a wide audience.

## CCS CONCEPTS

• **Human-centered computing** → **Interaction devices**.

## KEYWORDS

electronic waste, making, electronics, reuse, recycling

### ACM Reference Format:

Jasmine Lu, Ilan Mandel, Wendy Ju, and Pedro Lopes. 2024. (W)E-waste: Creative Making with Rescued Computing Devices. In *Creativity and Cognition (C&C '24)*, June 23–26, 2024, Chicago, IL, USA. ACM, New York, NY, USA, 3 pages. <https://doi.org/10.1145/3635636.3660761>

## 1 BACKGROUND

An often ignored side effect of the proliferation of new, innovative technologies are the piles of e-waste that get generated along the way. Consumer market trends, low repairability, and planned obsolescence all contribute to how often devices become discarded. E-waste is the largest growing consumer waste stream in the world

[2]. The average person generated an average of 7.3kg of e-waste and only 1.7kg of it was properly recycled in 2019 [14]. Clearly, e-waste is becoming an increasingly common and ubiquitous part of our lives and environments.

However, beyond using e-waste for extracting precious metals (so-called urban mining), e-waste is seldom thought of as valuable material for *making with*. This is due to several reasons. For one, whereas other materials (e.g., textiles, woodcraft, plastics, etc.) are more commonly creatively repaired or repurposed, doing so with electronic devices may often seem out of reach. In fact, a study on repair and re-purposing processes by Maestri and Wakkary found that "the simple nature of mechanical objects enable repair, though the presence of electronics and computational mechanisms in digital objects add further complexity that make adaptations and resourcefulness difficult" [8]. Additionally, computational devices are often conceptualized by end-users as black boxes, a type of thinking that obfuscates the fact that they are comprised of various modules, sensors, and circuitry—all ripe for creative re-uses. Last, there is a lack of tools and resources to scaffold processes in creatively making with e-waste.

Meanwhile, researchers in Human-Computer Interaction have highlighted how valuable e-waste can be when considered as material for creative making. In "Practices in the creative reuse of e-waste", Kim et al. illustrate how the usefulness of e-waste can be prolonged through creatively re-purposing e-waste materials [4]. Similarly, in "Recapturing Product as Material Supply: Hoverboards as Garbatrage", Mandel et al. examines the economic benefits of material recapture through e-waste over use of traditional supply chain pathways [10]. Finally, in "ecoEDA: Recycling E-waste during the Design Process", Lu et al. explores building electronic design tools to facilitate electronic component reuse during the design of new electronic devices [6]. Across these works, making with e-waste is also discussed as a means of more creatively engaging with the complex systems of computing infrastructure, manufacturing processes, and design strategies that go into producing devices. Additionally, reusing e-waste has pedagogical benefits, helping learners to understand how to build more sustainable and circular economies for our devices. We are interested in how these benefits of e-waste can be made more accessible to a broader audience, especially through employing crafty and creative approaches to remixing and re-purposing e-waste material.

**In this workshop, we aim to further explore these creative making processes of re-purposing e-waste.** We aim to do this by focusing the majority of our workshop on facilitating hands-on



This work is licensed under a [Creative Commons Attribution International 4.0 License](https://creativecommons.org/licenses/by/4.0/).

C&C '24, June 23–26, 2024, Chicago, IL, USA  
© 2024 Copyright held by the owner/author(s).  
ACM ISBN 979-8-4007-0485-7/24/06  
<https://doi.org/10.1145/3635636.3660761>

teardowns and making activities with e-waste. In doing so, participants will explore the various challenges and opportunities of these processes through the construction of a small project from e-waste.

## 2 WORKSHOP GOALS & OUTCOMES

This workshop provides hands-on activities in tearing down e-waste and making creative projects with their parts. These activities are organized around three main goals: (1) documenting teardowns and re-use possibilities, (2) exploring making strategies and projects, (3) bringing creative making with e-waste to a wider audience.

### 2.1 Documenting Teardowns and Re-use Possibilities

Participants are provided with an array of e-waste devices that are amenable to reuse and re-purposing. Then, participants are encouraged to document their teardown of the devices and explore what could be remade with the device materials. Such documentation will be made available online as part of a larger repository after the workshop so that a larger audience may continue to explore how those devices could be creatively reused.

### 2.2 Exploring Making Strategies and Projects

Through their hands-on projects, participants are able to explore creative strategies for working with e-waste material. These might include *frankensteining* different devices together, or re-interpreting existing mechanisms. Additionally, we will encourage participants to document their project process and outcomes. With consent, this project documentation will be made available online so that others can replicate and build off their work.

### 2.3 Bringing Creative Making with E-waste to a Wider Audience

We aim to recruit participants from various backgrounds and will not require that they have prior experience in working with electronics. As electronics hacking/modding is often perceived as too complex for novices, we will explore how making with e-waste can be made more friendly. Throughout the day, participants will be encouraged to make note of what barriers and issues they encountered during their projects. These might include proprietary parts, lack of tools and resources, or lacking skills/knowledge. At the end of the day, we will discuss any challenges encountered and how interactive tools might be able to lower these barriers for a wider audience.

## 3 ORGANIZERS

The organizing team are all engaged in Human-Computer Interaction research around making with e-waste. Collectively, we build on our multiple experiences in e-waste reuse projects, workshops, and classroom assignments.

**Jasmine Lu** is a Ph.D. student at the University of Chicago. Her work explores how users can take on more sustainable relationships with interactive technologies. Her recent work explores reusing electronic components from e-waste during the design process [6]. She has facilitated multiple e-waste tear-down/making activities with participants of different backgrounds (i.e., students and

HCI researchers). At UIST 2023, she co-organized a workshop on sustainable making [15] and as part of the SIGCHI Sustainability Committee, interviews HCI Labs on their approach to prototyping with sustainability in mind.

**Ilan Mandel** is a Ph.D. researcher at Cornell Tech. His research focuses on designing scaleable reuse of e-waste. His recent work features a case study of "garbstrage," wherein designers exploit the difference in value between parts in waste product and those used in new products [10]. He is also interrogating the pedagogical benefits of teaching learners to dissect and re-animate consumer electronics [9].

**Wendy Ju** is an Associate Professor at the Jacobs Technion-Cornell Institute at Cornell Tech and the Technion. Her research examines how design approaches need to evolve in the face of new technologies and challenges. For example, Ju innovated early-stage prototyping of automated systems to understand how people will respond to systems before the systems are built, which have been widely adopted by academics and industry practitioners. [1, 12, 16]. At Cornell Tech, Ju teaches graduate level courses in Interactive Device Design.

**Pedro Lopes** is an Associate Professor in Computer Science at the University of Chicago and leads the Human Computer Integration. Pedro focuses on integrating interfaces with the human body—exploring the interface paradigm that supersedes wearables [11]. These include, for instance, muscle stimulation wearables that allow users to manipulate tools they have never seen before [5] or that accelerate reaction time [3]. Most recently, inspired by Jasmine Lu, Pedro explores how to engineer hardware devices with sustainability in mind [6, 7, 13].

## 4 WORKSHOP PLAN

### 4.1 Schedule

*Activity 1 - Opening, introductions, and short tour (9:00-9:30).* Our workshop will begin with a short introductory session, discussing the scheduled activities of the day and framing how creative making with e-waste connects to HCI research. Next, we will do a short ice-breaking activity to allow all workshop organizers and attendees will introduce themselves and share on their interest in the topic. Last, we will do a short tour of the space and an overview of the tools/resources we will have available for use throughout the day.

*Activity 2 - Tutorials: Safety, Scavenging Tips, and Reuse Demos (9:30-10:30).* The organizers will present tutorials to scaffold the days activities. These will cover (1) safety practices when tearing down devices and reusing electronics, (2) strategies for identifying and testing useful material when scavenging, and (3) demos for how to re-use and reprogram a specific micro-controller from e-waste. These tutorials will be organized around giving attendees of all backgrounds a solid foundation to begin Activity 3.

*Activity 3 - Hands-on teardowns and making (10:30-12:00 & 13:30-15:00).* Participants will be given free time to teardown and build their own projects from e-waste (with a break for lunch). To facilitate this, organizers will have pre-collected e-waste devices, such as old printers, IoT devices, or e-cigarettes, that we feel comfortable tearing down and reusing. Similarly, we will have project ideas for participants if they get stuck (for example, building off our tutorial

on reusing a micro-controller from an e-waste device). Throughout this activity, organizers will also be on hand to help participants brainstorm and troubleshoot their projects. However, we hope to encourage participants to get creative in their explorations of making with e-waste.

*Activity 4 - Documenting and Presenting Projects (15:00 - 15:30).* After wrapping up their projects, participants will document and share their work. Participants will be encouraged to walk the larger group through all their processes (ideation, research, testing, assembly, troubleshooting, etc.) and whatever challenges they encountered.

*Activity 5: Reflection & Discussion (15:30-16:00).* Participants will be split into groups for a short brainstorming and reflection session. They will be prompted to discuss the main challenges encountered during their projects and how HCI research might be able to alleviate them. Each group will share what they discussed at the end.

## 4.2 Venue

We will use the Human Computer Integration Lab's space at the University of Chicago for workshop activities. By using this space, we will have access to tools (soldering irons, heat guns, laser cutter, machine tools, etc.) to support a wide range of making activities that might be useful for participants' projects. We will arrange to accommodate all workshop participants needs and will provide detailed instructions for how to arrive at the location from the conference venue. This venue is about 20 minutes by car from the main conference venue and also accessible by bus, Metra, or Red/Green Line CTA trains.

## 4.3 Audience and Promotion

We welcome anyone interested in upcycling e-waste devices regardless of prior background and skill (participants without any electronics experience are also encouraged to join). As this will be an hands-on, activity-based workshop, participants will not be asked to submit any short paper or prepare presentations/demos of their prior related work. They may, but are not required to, bring e-waste they are interested in taking apart. Workshop organizers will promote the workshop across social media channels and relevant mailing lists.

## REFERENCES

- [1] Sonia Baltodano, Srinath Sibi, Nikolas Martelaro, Nikhil Gowda, and Wendy Ju. 2015. RRADS: real road autonomous driving simulation. In *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction Extended Abstracts*. 283–283.
- [2] Vanessa Forti, Cornelis Peter Baldé, Ruediger Kuehr, and Garam Bel. 2020. The global e-waste monitor 2020. *United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam 120* (2020).
- [3] Shunichi Kasahara, Jun Nishida, and Pedro Lopes. 2019. Preemptive Action: Accelerating Human Reaction using Electrical Muscle Stimulation Without Compromising Agency. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland UK) (*CHI '19*). Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3290605.3300873>
- [4] Sunyoung Kim and Eric Paulos. 2011. Practices in the creative reuse of e-waste. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2395–2404.
- [5] Pedro Lopes, Patrik Jonell, and Patrick Baudisch. 2015. Affordance++: Allowing Objects to Communicate Dynamic Use. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (Seoul, Republic of Korea) (*CHI '15*). Association for Computing Machinery, New York, NY, USA, 2515–2524. <https://doi.org/10.1145/2702123.2702128>
- [6] Jasmine Lu, Beza Desta, K. D. Wu, Romain Nith, Joyce E Passananti, and Pedro Lopes. 2023. ecoEDA: Recycling E-waste During Electronics Design. In *Proceedings of the 36th Annual ACM Symposium on User Interface Software and Technology* (San Francisco, CA) (*UIST '23*). Association for Computing Machinery, New York, NY, USA, Article 30, 14 pages. <https://doi.org/10.1145/3586183.3606745>
- [7] 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* (Bend, OR, USA) (*UIST '22*). Association for Computing Machinery, New York, NY, USA, Article 28, 13 pages. <https://doi.org/10.1145/3526113.3545629>
- [8] Leah Maestri and Ron Wakkary. 2011. Understanding repair as a creative process of everyday design. In *Proceedings of the 8th ACM Conference on Creativity and Cognition*. 81–90.
- [9] Ilan Mandel and Wendy Ju. 2023. Frankenstein's Toolkit: Prototyping Electronics Using Consumer Products. *arXiv preprint arXiv:2303.13618* (2023).
- [10] Ilan Mandel and Wendy Ju. 2023. Recapturing Product as Material Supply: Hoverboards as Garbatrage. In *Proceedings of the 2023 ACM Designing Interactive Systems Conference*. 564–579.
- [11] Florian Floyd Mueller, Pedro Lopes, Paul Strohmeier, Wendy Ju, Caitlyn Seim, Martin Weigel, Suranga Nanayakkara, Marianna Obrist, Zhuying Li, Joseph Delfa, Jun Nishida, Elizabeth M. Gerber, Dag Svanaes, Jonathan Grudin, Stefan Greuter, Kai Kunze, Thomas Erickson, Steven Greenspan, Masahiko Inami, Joe Marshall, Harald Reiterer, Katrin Wolf, Jochen Meyer, Thecla Schiphorst, Dakuo Wang, and Pattie Maes. 2020. Next Steps for Human-Computer Integration. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (*CHI '20*). Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3313831.3376242>
- [12] Dirk Rothenbücher, Jamy Li, David Sirkin, Brian Mok, and Wendy Ju. 2015. Ghost driver: a platform for investigating interactions between pedestrians and driverless vehicles. In *Adjunct Proceedings of the 7th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*. 44–49.
- [13] Shan-Yuan Teng, K. D. Wu, Jacqueline Chen, and Pedro Lopes. 2022. Prolonging VR Haptic Experiences by Harvesting Kinetic Energy from the User. In *Proceedings of the 35th Annual ACM Symposium on User Interface Software and Technology* (Bend, OR, USA) (*UIST '22*). Association for Computing Machinery, New York, NY, USA, Article 39, 18 pages. <https://doi.org/10.1145/3526113.3545635>
- [14] United Nations: Department of Economic and Social Affairs. 2021. *The sustainable development goals report 2021*. United Nations, New York, NY.
- [15] Zeyu Yan, Tingyu Cheng, Jasmine Lu, Pedro Lopes, and Huaishu Peng. 2023. Future Paradigms for Sustainable Making. In *Adjunct Proceedings of the 36th Annual ACM Symposium on User Interface Software and Technology* (San Francisco, CA) (*UIST '23 Adjunct*). Association for Computing Machinery, New York, NY, USA, Article 109, 3 pages. <https://doi.org/10.1145/3586182.3617433>
- [16] J.D. Zamfirescu-Pereira, David Sirkin, David Goedicke, RAY LC, Natalie Friedman, Ilan Mandel, Nikolas Martelaro, and Wendy Ju. 2021. Fake It to Make It: Exploratory Prototyping in HRI (alt.HRI). In *Companion of the 2021 ACM/IEEE International Conference on Human-Robot Interaction*.