

(DIY)biology and Opportunities for HCI

Stacey Kuznetsov¹, Alex S. Taylor², Eric Paulos¹, Carl DiSalvo³, Tad Hirsch⁴

Carnegie Mellon University¹
Human-Computer Interaction
Institute
Pittsburgh, PA 15213 USA
{stace, paulos}@cs.cmu.edu

Microsoft Research²
7 J J Thomson Avenue,
Cambridge, UK
ast@microsoft.com

School of Literature
Communication & Culture³
Georgia Institute of
Technology Atlanta, GA
carl.disalvo@lcc.gatech.edu

University of Washington
School of Art⁴
Seattle, WA, USA
thirsch@uw.edu

ABSTRACT

Over the past decade, a diverse community of biologists, artists, engineers and hobbyists has emerged to pursue biology projects outside of traditional laboratories. Though still in its nascent form, this DIYbio (Do It Yourself Biology) movement has given rise to a host of technical innovations and sharing mechanisms that enable hobbyists to experiment with organic materials. As these developments continue to expand science practice beyond professional settings and into hackspaces, art studios and private homes, HCI research is presented with a range of new opportunities and concerns.

Our workshop will bring together a diverse group of designers and HCI researchers, as well as biologists, bioartists, and members of the DIYbio community to critically re-envision the role HCI might play at the intersection of biology, computation and DIY. This action-based one-day workshop will engage directly with DIYbio initiatives in the UK to explore the materials, practices and challenges of ‘garage biology’. Drawing on presentations from DIYbio participants who work with organic materials, hands-on biology activities (such as extracting DNA), and structured discussions, we hope to address themes such as: opportunities and implications for integrating organic materials into interactive systems; technologies that support and hinder public engagement with science; and HCI’s role in the public discourse around bioethics and biosafety.

Author Keywords

DIYbio, synthetic biology, DIY

INTRODUCTION

A growing body of HCI and DIS research explores *citizen science* methods and applications that enable members of the general public to collect, analyze and act on scientific data [2]. From participatory sensing to health advocacy, food production and personal monitoring, novel DIY (do it yourself) tools and low cost technologies are emerging to support ‘science’ in the hands of non-experts. In this workshop, we focus on DIYbio—Do It Yourself Biology—a movement that embraces biology (*science* in the most

literal sense) outside of professional settings.

DIYbio has co-evolved with several ‘open source’ developments in synthetic biology, a bioengineering branch within biology. Initiatives such as OpenWetWare, a wiki-style collection of data a protocols [13], the Registry of Standard Biological Parts, a collection of genetic parts that can be assembled into biological systems [15], and the International Genetically Engineered Machine competition (iGEM) have enabled broader access to scientific information and materials [10]. Inspired by ideas of openness as applied to biology, hobbyists have coalesced into regional DIYbio groups, among them Genspace [8], a BSL1-certified open laboratory in New York City, IndieBiotech [9], a startup aimed at creating affordable biology tools for non-experts, and Manchester DIYbio [5], a group funded by the Wellcome Trust to further public engagement with science in the U.K., to name a few. DIYbio projects range from biosensors, genetic modification of organisms and experiments with food, to the creation of biology equipment from off the shelf parts. In parallel, bioartists around the world are incorporating organic materials into a variety of projects to explore the complex relationships between humans and biotechnology, and the emerging ethical issues. Examples include Zaretsky’s work with transgenic organisms [7], Dumitriu’s infective textiles [6], or the Critical Art Ensemble’s performative genetic experiments [3].

These distributed initiatives are supported by diybio.org, a forum boasting nearly 2000 members, “dedicated to making biology an accessible pursuit for citizen scientists, amateur biologists and biological engineers who value openness and safety” [4]. This forum invites professionals, artists and hobbyists to discuss issues from the practical (biology protocols and equipment exchange, *etc.*) to the more philosophical, such as questions of the ethics of tampering with nature. In addition, a number of low-cost kits that reproduce the functionality of lab equipment are now available for purchase and assembly, including OpenPCR [12], or Pearl Biotech’s open gel box [14].

Not surprisingly, the emergent ‘biohacking’ and ‘garage biology’ culture echoes some of the practices of previously studied DIY communities such as craft or electronics groups [1, 11, *etc.*]. DIYbio revolves around tinkering, ‘hacking’, playing with and reconfiguring materials and systems. However, the materials worked with—living

Permission to make digital or hard copies of all or part 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. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

DIS 2012, June 11-15, 2012, Newcastle, UK.

Copyright 2012 ACM xxx-x-xxxx-xxxx-x/xx/xx...\$10.00.

organisms, bio-electronic configurations and even parts of the human body—introduce a host of new challenges and opportunities for HCI and DIS research. These include novel techniques for ‘crowdsourcing’ biology experiments and visualizing data, bio-electronic configurations for working with organic materials, and design explorations to foreground the surrounding bioethical issues.

WORKSHOP DESCRIPTION

We propose a one-day workshop, focusing on the materials, practices, goals and challenges of the DIYbio movement. This workshop will bring together HCI researchers, designers, scientists, hobbyists and artists who are interested in or already working at the intersection of biology, technology and DIY. We will work directly with (DIY) biology practitioners, including bioartists and guest speakers from the DIYbio communities in Manchester and London. The workshop will be structured around several hands-on biology-related activities, which will be used to seed discussions about the role of HCI and design in this emerging space.

Proposed schedule

Time	Activity
9:00am-10:30	Welcome and introductions by organizers. Presentations by participants including: their background; a biology-related project or area of interest; several topics or questions to be discussed in the workshop.
10.30-11.00	Break
11:00-12:30pm	Bio-materials and activities. Break out into groups for hands-on biology activities and discussions. Each group will be led by a (DIY)biology practitioner. Activities might include: DNA extraction, creating microscopes from cellphone cameras or webcams, casting agar plates, taking swab samples, etc. At the end of the hands on activity, each group will brainstorm questions, concepts, challenges and ideas related to their project.
12:30-2:00	Lunch
2:00-3:00	Bio-brainstorming. Each group reports back experiences from their hands-on activities. We then collectively brainstorm themes and concepts that emerged from these activities and participants’ morning presentations. Identify several core areas.
3:00-4:00	Break out into groups, and each group discusses a core area and brainstorms possible avenues for HCI research.
4:00-4:30	Break
4:30-5:30	Synthesis and wrap-up

Goals

Our workshop will engage directly with DIYbio and bioartist communities. In doing so, we hope to gain unique insights into the day-to-day projects and materials of ‘garage biology’ practitioners, as well as the broader goals and implications of the DIYbio movement. In addition to participants’ presentations of their work, we will explore DIYbio through a series of hands-on activities. Working directly with biology-related materials—both technological and organic—the workshop will expose the unique issues associated with pursuing biology outside of traditional laboratories. The workshop will thus present a venue for researchers, designers and practitioners to discuss the ‘garage biology’ movement and critically envision the emerging opportunities for interaction design research.

Our overarching goal is to explore a range of design issues at the intersection of biology, technology and DIY. We will consider issues from the practical challenges and opportunities for sharing knowledge across communities of professional biologists, DIY hobbyists and the general public, to the broader implications of incorporating organic materials into interactive systems and treating living organisms as inputs and outputs to digital technologies. Our workshop will also touch on the role HCI can play in foregrounding ethical and safety questions of ‘redesigning’ nature and placing biology in the hands of non-experts.

Themes

We hope to address the following themes through hands-on activities and collective brainstorming and discussions:

- *Goals and motivations.* Similar to other DIY communities (craft, electronics, etc.), biology hobbyists share a passion for tinkering, hacking and ‘playing with’ organic materials. However, since biology practice has been generally confined to professional laboratories, DIYbio is inevitably motivated by socio-political aspirations to ‘open source’ biology and unsettle traditional modes of science making. How do biology hobbyists navigate the tensions between play and politics, and how can HCI be leveraged to support these complex motivations?
- *DIYbio tools materials.* DIYbio projects rely on a unique set of tools and materials. These include traditional biology equipment such as incubators, glassware or PCR machines, as well as improvised assemblies that replicate laboratory functionality using off-the shelf parts at a fraction of the cost. How are materials acquired, repurposed and/or assembled? How do materials (their availability or lack thereof) shape DIY biology practices? How can novel technologies facilitate ‘open access’ to materials outside of professional labs?
- *Knowledge and expertise sharing.* Although the DIYbio movement aims to make biology accessible to non-experts outside of professional settings, the

majority of DIYbio groups are led or assisted by professional biologists. The diybio.org mailing list serves as a meeting point for practitioners with varying backgrounds and degrees of expertise. How can novel technologies, beyond text-based mailing lists, support learning and sharing across communities of experts and hobbyists? What new mechanisms might enable knowledge sharing in biology laboratories (DIY or professional)? How can new forms of information be integrated into and/or shared during wetlab experimentation?

- *Coordination and power structures.* Related to the above point, collaborations between professionals and non-experts contrast the non-hierarchical structures and processes of other grassroots movements. How do DIYbio groups coordinate their work and materials with professional biologists and institutions while maintaining a bottom-up organization? What new methods and technologies can be applied to support decentralized power structures in these communities? How can HCI researchers collaborate with DIYbio groups—and particular members—without subverting power structures and community relations?

- *Challenges and constraints.* As a grassroots movement, DIYbio inevitably faces unique financial, material and social constraints. What are the challenges associated with DIYbio and how do communities work around them? How do new groups address the practical issues of acquiring labspace, managing resources, nurturing relationships with professionals, and building momentum (*i.e.* enticing ongoing biology projects)? What are the broader political and legal constraints around practicing biology outside of professional settings and how do hobbyists navigate these? How can HCI researchers collaborate with DIYbio groups to help mediate the challenges associated with hobby biology?

- *Public engagement.* What mechanisms and tools are used to engage members of the general public in biology projects? What technologies are being used to make biology more accessible and transparent to non-experts? How do DIYbio practitioners reconcile public concerns regarding the safety and ethics of their practice? What new technologies might emerge to initiate dialogues between biology practitioners and stakeholders amongst the general public?

- *Ethics and safety.* As a consequence of working with living and organic materials, DIYbio faces a range of ethical and safety concerns. Practically speaking, individuals pursuing biology outside of professional settings often do not have access to tools and infrastructures for addressing biosafety questions such as disposal, sterilization or invasive species. More broadly, biology hobbyists must consider a host of questions regarding the ethics of their work (such as, for instance, the ethics of harvesting or experimenting with

living organisms). How can HCI and design interventions be used to foreground questions of ethics and safety and facilitate public discourse around DIYbiology?

- *Bio-electronic hybrids.* DIYbio projects rely on systems that integrate organic materials with digital technologies (among them PCR machines, incubators, *etc.*). Such assemblies reveal tensions between living and digital artifacts and our treatment of these. For instance, living organisms rely on nutrients and care, operating at unique, often unpredictable timescales. What are the challenges and opportunities for interactive systems that leverage organic materials as inputs and outputs?

Expected outcomes

During the workshop, participants will gain a shared understanding of ‘garage biology’, including the practices, materials and challenges of this movement. The hands-on activities will enable participants to *experience* some of the issues associated with working with organic materials. Workshop activities and emerging themes will be documented on the workshop website, which will remain active after DIS’12. Artifacts created during the workshop will be showcased throughout the DIS conference. The gathering of HCI researchers, artists, biologists and hobbyists may result in longer-term collaborations and inspire novel research around DIY biology.

Author Biographies

Carl DiSalvo is an assistant professor in the School of Literature, Communication and Culture, at the Georgia Institute of Technology. His research concerns the development of new forms of participatory design and humanities-based approaches to interaction design and human-computer interaction design criticism.

Tad Hirsch is an Assistant Professor in Design at the University of Washington. His research interests include civic engagement, sustainability, and collective action.

Stacey Kuznetsov is a Ph.D. candidate at Carnegie Mellon University’s Human Computer Interaction Institute. Her research explores political computing and citizen science.

Eric Paulos is an Associate Professor in the Human Computer Interaction Institute at Carnegie Mellon University. His research interests include urban computing, sustainability and citizen science. He has organized numerous workshops at CHI and UbiComp.

Alex S. Taylor is a researcher at Microsoft Research Cambridge (UK). He has applied a sociological perspective to a range of topics in HCI, including home life, machine intelligence and most recently computational biology.

CALL FOR PARTICIPATION

DIYbio (Do It Yourself Biology) is a growing community of biologists, artists, engineers and hobbyists who pursue biology projects outside of professional laboratories. These

range from gardening and experiments with food, to creating biosensors, genetically modifying organisms or developing biology equipment from off the shelf parts. As a result, a host of technical innovations, tools and sharing mechanisms is emerging to enable non-experts to experiment and play with organic materials. As these developments continue to expand science practice beyond professional settings and into hackspaces, art studios and private homes, HCI research is presented with a range of new opportunities and concerns.

This one-day workshop will bring together a diverse group of designers, biologists, bioartists, and members of the DIYbio community to critically re-envision the role HCI might play at the intersection of biology, computation and DIY. We will work directly with (DIY) biology practitioners, including bioartists and members from the U.K. DIYbio Manchester and London communities. The workshop will be structured around several hands-on biology-related activities, which will be used to seed brainstorming and discussions about the role of HCI and design in this emerging space. Workshop themes include:

- (DIY)biology motivations, projects and practices
- Materials and tools employed by DIYbio; and technologies that facilitate (or hinder) 'open access' to biology outside of professional settings
- DIYbio constraints and challenges (legal, financial, social, cultural, etc.) and resulting workarounds
- Tools for knowledge and expertise sharing across communities of professional and DIY biologists
- Technologies and methods that support (or hinder) public engagement with science
- Bioethics and biosafety, including questions of 'redesigning' nature and placing biology in the hands of non-experts
- Bio-electronic assemblies and the future of interactive systems that incorporate living organisms with digital technologies

Interested participants are invited to submit using one of three artifacts:

- Position paper in DIS archival format (maximum 2 pages)
- An example (photograph or video and description) of a prior (DIY) biology project
- A creative proposal for a project or design exercise to engage with DIYbiology

In addition, participants are asked to submit a brief (200 word) personal biography and photo.

Submissions will be accepted based on originality and quality, and will represent a spectrum of viewpoints and participant backgrounds. Submissions from underrepresented disciplines in the HCI community will be particularly welcome (e.g., biology, art, anthropology,

literature, philosophy, political sciences). Submissions may be sent by email to the workshop organizers. For more information, please see the workshop webpage at [TBA]

RECRUITMENT STRATEGY

We hope to recruit a wide range of participants, including HCI and design researchers as well as individuals working with organic materials (gardeners, beer brewers, etc.), biologists, bioartists and members of the DIYbio community. Our workshop will be promoted in academic circles, especially reaching out to HCI researchers who previously explored DIY movements, political computing, citizen science and biology. In addition, leveraging our personal contacts, we will invite members of U.K.'s DIYbio groups in Manchester and London, as well as biology hobbyists working locally in Newcastle. We will also encourage participation from people involved in gardening, beekeeping, cooking and other biology-related activities by reaching out to local communities in Newcastle.

In addition to position papers, we will encourage submissions using one of two creative formats: 1) an example (photograph, video, description, *etc.*) of a prior (DIY)biology project; 2) a proposal for a project or design exercise to engage with a DIYbio community. Submissions will be reviewed by the organizers, and 15-20 will be accepted. Submissions will be placed on the workshop website.

REFERENCES

1. Buechley, L. and Hill, B. M. 2010. LilyPad in the wild: how hardware's long tail is supporting new engineering and design communities. In Proc. DIS '10. Pp. 199-207.
2. Burke, J., Hansen, M., Parker, A., Ramanathan, N., Reddy, S., Srivastava, M. B. "Participatory Sensing." WSW'06 at SenSys. Boulder: ACM, 2006.
3. Critical Art Ensemble. <http://www.critical-art.net/>
4. DIYbio. An Institution for the Do-It-Yourself Biologist. <http://diybio.org/>
5. DIY Biology: Manchester. <http://diybio.madlab.org.uk/>
6. Anna Dumitriu. <http://web.mac.com/annadumitriu/AD>
7. Electronic Mutagenesis. <http://www.emutagen.com/>
8. Genspace, New York City's Community Biolab. <http://genspace.org/>
9. IndieBiotech. <http://www.indiebiotech.com/>
10. International Genetically Engineered Machine competition. "Synthetic biology based on standard parts". <http://ung.igem.org/>
11. Kaye, J., Williams, A. and Oehlberg, L. Tinkering, Crafts and Inventive Leisure Practices. In press, Proc. CSCW'11.
12. OpenPCR. <http://openpcr.org/>
13. OpenWetWare. <http://openwetware.org>
14. Pearl Biotech. <http://www.pearlbiotech.com>
15. Registry of Standard Biological Parts. http://partsregistry.org/Main_Page