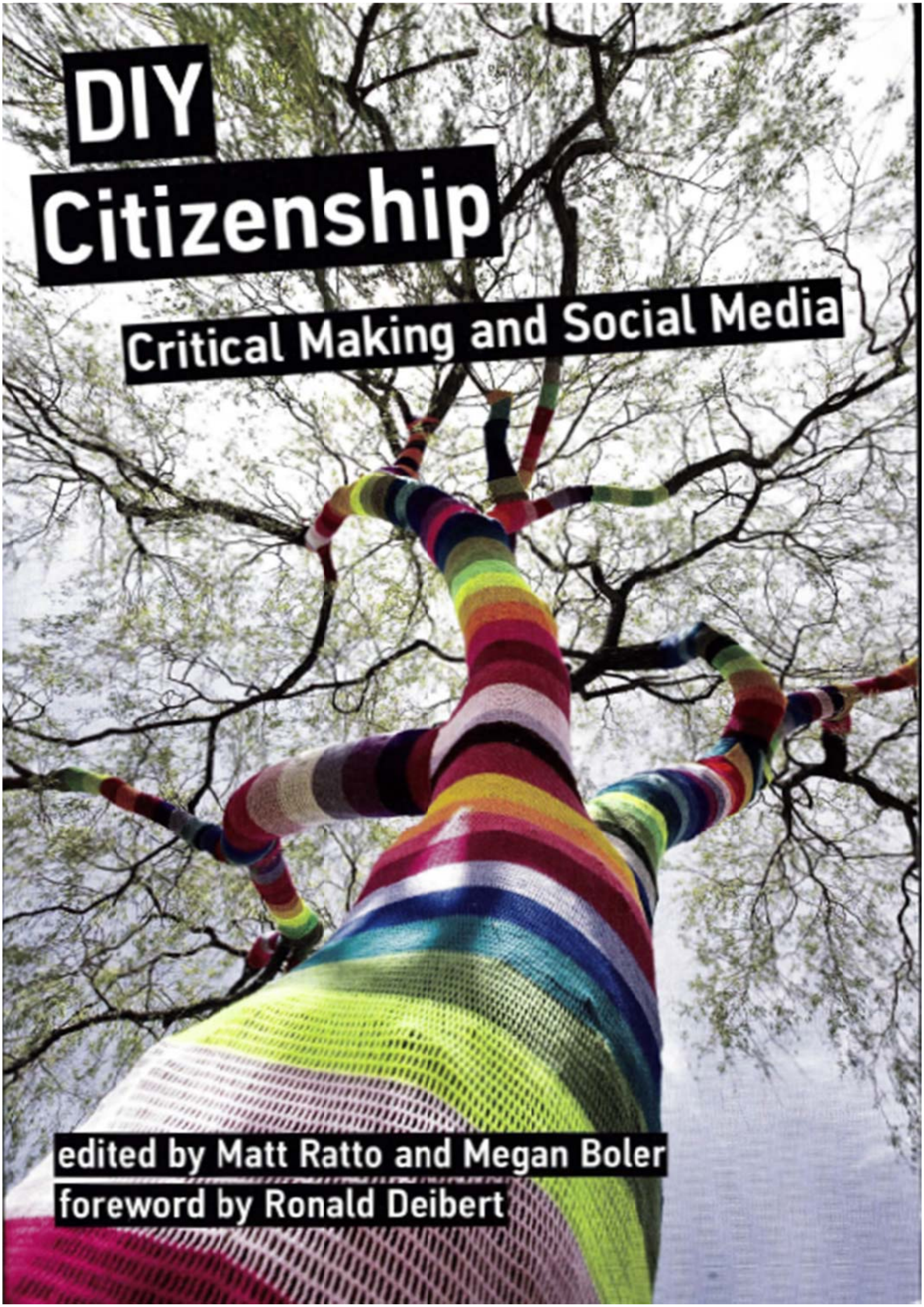
DIY Citizenship

Critical Making and Social Media



edited by Matt Ratto and Megan Boler
foreword by Ronald Deibert

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Contents

Foreword by Ronald Deibert ix

Introduction 1
Matt Ratto and Megan Boler

I DIY and Activism: New Modes of Civic Engagement and Participatory Politics 23

1 Maktivism: Authentic Making for Technology in the Service of Humanity 29
Steve Mann

2 (Re)making the Internet: Free Software and the Social Factory Hack 53
Kate Milberry

3 Fan Activism as Participatory Politics: The Case of the Harry Potter Alliance 65
Henry Jenkins

4 Radical Inclusion? Locating Accountability in Technical DIY 75
Christina Dunbar-Hester

5 Proportionate ID Cards: Prototyping for Privacy and Accountability 89
Brenda McPhail, Andrew Clement, Karen Louise Smith, Jennette Weber, Joseph Ferenbok, and Alex Tichine

6 Developing Communities of Resistance? Maker Pedagogies, Do-It-Yourself Feminism, and DIY Citizenship 101
Red Chidgey

7 **Rethinking Media Activism through Fan Blogging: How Stewart and Colbert Fans Make a Difference 115**
Catherine Burwell and Megan Boler

8 **Just Say Yes: DIY-ing the Yes Men 127**
Ian Reilly

II DIY and Making: Learning, Culture, Hacking, and Arts 137

9 **DIY Citizenship, Critical Making, and Community 141**
Kate Orton-Johnson

10 **Mélange of Making: Bringing Children's Informal Learning Cultures to the Classroom 157**
Alexandra Bal, Jason Nolan, and Yukari Seko

11 **Power Struggles: Knowledge Production in a DIY News Club 169**
Jennifer Jenson, Negin Dahya, and Stephanie Fisher

12 **Transparency Reconsidered: Creative, Critical, and Connected Making with E-textiles 179**
Yasmin B. Kafai and Kylie A. Peppler

13 **Woven Futures: Inscribed Material Ecologies of Critical Making 189**
Daniela K. Rosner and Miki Foster

14 **Making Publics: Documentary as Do-It-with-Others Citizenship 201**
Mandy Rose

15 **Mirror Images: Avatar Aesthetics and Self-Representation in Digital Games 213**
Suzanne de Castell

III DIY and Design: Opening the Black Box and Repurposing Technologies 223

16 **Textual Doppelgangers: Critical Issues in the Study of Technology 227**
Matt Ratto

17 **The Growbot Garden Project as DIY Speculation through Design 237**
Carl DiSalvo

18 **Doing It in the Cloud: Google, Apple, and the Shaping of DIY Culture 249**
Michael Murphy, David J. Phillips, and Karen Pollock

19 **Citizen Innovation: *Active*Energy and the Quest for Sustainable Design 259**
Ann Light

20 ***Le Champ des Possibles*—The Field of Possibilities 269**
Owen McSwiney and Emily Rose Michaud

21 **Distributed Design: Media Technologies and the Architecture of Participation 283**
Joel McKim

22 **"I hate your politics but I love your diamonds": Citizenship and the Off-Topic Message Board Subforum 295**
Lana Swartz and Kevin Driscoll

IV DIY and Media: Redistributing Authority and Sources in News Media 307

23 **Redesigning the Vox Pop: Civic Rituals as Sites of Critical Reimagining 313**
Joshua McVeigh-Schultz

24 **Alternative Media Production, Feminism, and Citizenship Practices 329**
Rosa Reitsamer and Elke Zobl

25 **Alternative Media, the Mundane, and "Everyday Citizenship" 343**
Chris Atton

26 **Critical News Making and the Paradox of "Do-It-Yourself News" 359**
Mike Ananny

27 **Social Media, Visibility, and Activism: The *Kony 2012* Campaign 373**
Graham Meikle

28 **A Digital Democracy or Twenty-First-Century Tyranny? CNN's iReport and the Future of Citizenship in Virtual Spaces 385**
Devan Bissonette

List of Contributors 403
Index 415

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12 Transparency Reconsidered: Creative, Critical, and Connected Making with E-textiles

Yasmin B. Kafai and Kylie A. Peppler

In this chapter, we consider how students' and adults' work with electronic textiles can expand our understanding of "transparency"—revealing power structures and constraints in the design and use of new media—a core idea promoted in participatory media[1] and critical design.[2] Electronic textiles (e-textiles), which include young people's design of programmable garments, accessories, and costumes, incorporate elements of embedded computing that allow for controlling the behavior of fabric artifacts, novel materials that can include conductive fibers or Velcro, sensors for light and sound, and actuators such as LEDs and speakers, in addition to traditional aspects of textile crafts. E-textiles can be considered a part of a larger DIY movement to promote personalized fabrication outside traditional manufacturing that can also extend into classrooms.[3]

We see the additional benefit in revealing insights about the production or design of technology itself and cultural assumptions that nowadays are often hidden or "invisible" to youth. Creative production with e-textiles encourages students and adults to question their current understandings of functionality and aesthetics, make explicit their gendered assumptions about crafts, and master the fundamentals of a new field by learning the visual, aural, and technological literacies necessary to inscribe one's self into the larger DIY and fashion culture.[4] All in all, what takes place during such creative production becomes a critical reflection on how technology design decisions are made, how they are interrelated with craft production and engineering functionality, and how they intersect with personal choices and cultural assumptions. We examine these ideas by first outlining the different perspectives, their historical antecedents, and relevant research in the constructionist tradition. We then present examples from our own research with youth and adults in e-textile workshops that illustrate how the visibility of production affords opportunities for critical engagement.

Finally we discuss how this type of production holds the potential to disrupt gender divides that are often ubiquitous in educational settings focused on high-tech media.

Constructionist Perspectives on Transparency

Our goal in using transparency as an aspect of criticality draws from approaches in media and critical design education. The field of media literacy posits that when learners understand how ownership in media works, they begin to see how information is produced and positioned. Media scholars[5] have explicitly included creative designs, ethical considerations, and technical skills in their exploration of youths' expressive and intellectual engagement with new media. They place an emphasis on creative production because it empowers individuals to redefine their position within established power structures and learn "to see clearly the ways that media shape perceptions of the world."[6] Along with the necessity of developing technical skills and ethics, the understanding of power structures has been seen as a key aspect of digital citizenship. Here, transparency is a goal that learners need to accomplish in order to understand media, and educators rooted in this tradition frequently use youths' *engagement with media* to illustrate issues of power in production.

More recently, scholars engaged in the examination of critical design have expanded the notion of transparency by focusing on the connections that designers develop in the process of creative production. This work picks up on the emotional connections and relationships that people form with technology and uses them as springboards for critical reflection "to turn the relationship between technology and society from a 'matter of fact' to a 'matter of concern.'"[7] This approach to critical design is aligned with the open source movement that allows users the necessary access to build more complex understandings of the way things work. Classes in which students use open source software and build artifacts provide students with critical understandings of production and programming processes. Transparency in these educational settings is afforded by students' *reflection with media*.

While proponents of both approaches agree that creative production can be a valuable pathway into a critical understanding of power structures and relationships, we offer a complementary perspective on transparency as a vehicle for learning. Most of today's technology designs intentionally make invisible what makes them work; yet, for educational purposes, visibility is more beneficial in promoting learning.[8] In e-textiles, for example, the fabrication of stitches, circuits, and codes reveals the underlying structures in tangible and observable ways. Like participatory media studies, we stress the importance of making media designs as a way to understand the world. Like critical design studies, we see programming and open source technology as a way to "look under the hood." Transparency in educational applications thus comes from learners' *building with media*.

Underpinning all of these approaches is a fundamental view that learning happens best while in the process of making shareable artifacts, which is at the heart of constructionist theory.[9] Constructionist activities afford transparency by providing opportunities for concretizing knowledge and highlight "the reconnection of two modes of engagement with the world that are usually held separate: critical thinking, traditionally understood as conceptually and linguistic based, and physical 'making', goal-based material work."[10] The constructionist paradigm, by encouraging the externalization of knowledge, promotes seeing the knowledge object as a distinct "other" with which we can come into meaningful relationship. This relationship consists of questions that makers ask themselves about how the external object connects to other bodies of knowledge.[11] New forms of creative interactions afforded by these connections are some of the main affordances of working with open technologies that do not hide relationships, but rather leave them open in addition to extending them to crafts and arts beyond the traditional science, technology, engineering, and math (or STEM) focus that has dominated most of the critical considerations of technology production.

It is how we come to build these knowledge relationships that is at the center of our work with e-textiles. As Turkle and Papert have argued, there are preferred ways of working with technologies, the hard over the soft, that value the formal over the concrete.[12] E-textiles complicate the relationships we have preestablished with technology in multiple ways. There is a historically gendered notion that sewing and fabric fall nearly exclusively in the domain of females, while engineering and programming are traditionally seen as within the domain of males. Furthermore, there are tensions between aesthetics and functionality that, in particular, bring out the personal in e-textiles design because these artifacts are often carried close by their designers and might have a purpose in everyday life. In contrast, the corresponding domain of robotics often seems to exist for the sole purpose of competition. We argue that e-textiles are domain-crossing objects that provide fertile contexts for revisiting and remaking relationships with technology.

Critical Tensions in E-textile Designs

Our observations draw from a series of workshops with e-textiles that we organized with diverse groups of youth and adults over the last two years. Our goal was to engage participants in learning crafts, circuitry, and coding while making e-textile artifacts. The *LilyPad Arduino* construction kit enables novice engineers/designers to embed electronic hardware into textiles.[13] Users sew LilyPad modules together with conductive thread and employ the popular Arduino or ModKit development environments to program the LilyPad microcontroller to manage sensor and output modules (like LEDs) employed in their designs. Since its commercial release in 2007,[14] LilyPad Arduino has been widely adopted by designers and engineers of all ages from around the world and employed in a number of universities in computer science, engineering, fine arts, and design courses.

The following examples are drawn from e-textile workshops with middle school youth and female engineers. Taken together, these examples illustrate how technology design decisions are made, how they are interrelated with craft production and engineering functionality, and how they intersect with personal choices and by extension promote critical reflection within locally situated e-textiles contexts.

In a middle school, six boys and four girls signed up for the e-textile workshop, meeting twice a week in an open atrium for one month. They gathered around tables where LEDs, switches, batteries, needles, and conductive thread as well as t-shirts, canvas bags, and various decorative materials were displayed. Before starting on their projects, the youth were shown a few pictures of e-textile projects and given a tutorial on how to sew an electronic circuit. They were immediately drawn to the creative possibilities of the LED assortment on the tables, though were more halting as they deliberated possible designs on T-shirts or bags. Over the course of the workshop, youth brought in supplementary materials, providing opportunities for further personalization (see figure 12.1). While all students initially laid out their complete and functional circuits by connecting alligator clips to batteries, switches, and LEDs, the move onto fabric inevitably brought its own challenges: the polarity of LEDs was often misaligned or thread endings were not properly knotted, revealing that the students' understanding of circuitry wasn't entirely infallible.

Yet there was a palpable unease when the project started and the boys saw the fabric and realized they had to sew. Throughout the weeks, the unfamiliarity of sewing—threading the conductive thread as well as guiding

Figure 12.1
Images of completed projects from the middle-school workshop (two panels at left) and Women in Computing conference (two panels at right)

the needle through the fabric to make stitches—remained a major hurdle for all students except for one girl whose grandmother had taught her how to sew. It was also difficult for the youth to explain to others what exactly they were working on. When other students passed by the atrium, looking curiously at the tables covered with fabric and other materials, two of the participating boys immediately shouted "We're doing circuits!" while holding up their t-shirts, hinting at their identification with the more masculine aspects of the activity.

The 2011 Women in Computing conference provided a second opportunity to engage learners with the LilyPad Arduino in a less formal learning environment. Over one hundred women ranging from undergraduate students to tenured professors gathered for a three-hour e-textiles workshop. The objective of the workshop was to introduce a burgeoning field to an audience already steeped in the language of computing and engineering. After a brief presentation, the group was led through a series of steps that detailed the fundamentals of circuitry and sewing. In the process, participants utilized a simple set of e-textiles materials to create unique artifacts, including circuitry-enhanced bracelets, conference bags, gloves, and more.

And, yet, the abilities of the participants to create their projects were only slightly higher than those of the participants in our middle school workshops, despite this audience's experience with advanced programming, robotics, computer science, and engineering. Several participants worked ahead of the rest of the group, assuming that they would know what to do, only to run into hurdles down the line. Frequent mistakes included participants sewing through the circuit in one continuous thread, thus returning the power directly back to the battery source and shorting out the connection; underestimating the need for solid connections; misunderstanding polarity concepts when putting multiple lights in parallel; not even knowing how to tie basic knots, improperly tying a knot, or improperly threading a needle. Interestingly, the women who excelled in the activity were all older in age and more accustomed to the material science of working with fabric, needles, and thread. For them, the electronics were a natural extension from their prior experiences with traditional crafts.

The experiences in these workshops call two tensions to our attention. The first concerns a lack of transparency in traditional computing: the initial explorations of well-educated scholars with these materials brought their small misconceptions of circuitry concepts, such as polarity (the direction of energy), connectivity (the stability of connections), and flow (the circular path), to the fore. This was expected of middle school students but not of the more experienced engineers. However, most participants were able to connect to the wide bodies of knowledge with which they were familiar once a demonstrator made the initial parallels between the materials. The new materials thus made it more apparent that participants had understood before, but had some lingering misconceptions when transferring this understanding to a new domain—working with such a transparent medium underscores the importance of seeing how these engineering concepts apply across a range of media and conditions.

The second tension touches on a larger cultural trend concerning the role of a woman in engineering and computer science fields. The evident atrophy of a historically feminine activity (i.e., sewing) across the two youngest generations represented at the conference points to some academic females' devaluing of "women-centric" knowledge and skills. And while the vast majority of participants were drawn into the activity—especially the aura of a communal sewing circle that permeated from it—a minority of women argued that e-textiles reinforced gender stereotypes, preferring that women get involved in more male-dominated activities like robotics. This seems indicative that "women's skills" are something from which women in STEM fields continue to distance themselves. Though the causes for this tension are multifarious and deeply engrained, our hope for women's involvement in e-textiles is to return cultural capital to these largely undervalued skill sets, recognizing the potential of the unique perspectives and insights they could bring to STEM fields. Furthermore, while female engineers may have adapted the dominant epistemology of computing and frown at bringing "women's skills" into the field, girls and women just entering computer science may find comfort in the bridge between their existing gendered identities and the scientific identity they are being asked to take on.

Personal and Critical Connections in DIY Design

We are just beginning to understand how youth and adults engage with e-textiles, a relatively new addition to the DIY community but one that is becoming part of a larger personal fabrication movement. With rarely an exception, most participants approach these activities with little prior knowledge or experience in sewing, circuit design, or programming, let alone having ever used the LilyPad Arduino construction kit. While some have argued that such tangible materials can promote transparency and aesthetic engagement with technology,[15] these considerations have been articulated in regard to traditional construction kits aimed at robotics and scientific instrumentation. E-textile artifacts have similar qualities to what Turkle and Papert describe as sitting "betwixt and between the world of formal systems and physical things; it [the computer] has the ability to make abstract concrete . . . by the same time it makes it visible, almost tangible and allows a sense of direct manipulation."[16] While Turkle and Papert made this reference to objects on the computer screen, the inferences apply even more so to e-textiles. Simple misconceptions become apparent that range from not understanding what insulation does for wire, and why it's needed, to what the relationships are between an energy source and its components. While each of these represents valuable learning insights, one could easily classify them under functional understandings. What's important here is that all of this happens in a context where designers want to build something of aesthetic and personal value and within this context begin to understand the coordination of design constraints. In a paradoxical way, e-textiles make it more complicated to build with technologies while making it simpler to enter the complex relationships with technology.

Most pronounced are of course the references to the gendered nature of e-textile materials and activities that slip into conversations throughout the workshops. When middle school boys label their activities "circuit design," this is an intentional reference to engineering as a more male-appropriate and highly valued activity. These distinctions are in fact more complex since they make reference to old stereotypes that are no longer viable; most girls and women do not know how to sew, and so the seeming advantage is no longer available. Yet we also know from a recent study by Buechley and Hill[17] that examined the participation of women in the LilyPad community, that their participation is indeed much higher here than in the more engineering-centric Arduino community. While the LilyPad is a more recent technology development, it also evokes the foundations of modern computing, bringing us back to the longstanding historical connections among women, textiles, and computing: for example, Ada Lovelace's notes on the analytical engine that resulted in the first "computer program" in the nineteenth century, and the Jacquard loom (1801), which though created for weaving complex patterns in textiles, is considered the first step in the history of computing hardware.

Furthermore, more nuanced understandings of how technology works with a broader range of materials is crucial for today's DIY citizenship, as more aspects of life have moved into the digital domain. Cultivating a citizenry that understands why knowing how to build technology is important for several reasons. On a general level, it promotes understanding of the basic functionalities that underlie the designs of technology encompassing aspects such as designs of interfaces and systems. Moreover these understandings also empower citizens on a political level, providing them with resources to question decisions and designs made by others. Finally, on a personal level, the abilities to use and make technologies for expressive purposes allow for better communication and relationships. The mind-and-hand merger of the digital and physical, additionally, is brought together through creative production with e-textiles, not only bringing these aspects to the foreground but also allowing learners to externalize knowledge and reformulate their misunderstandings. E-textiles reposition youth as active creators, rather than consumers, of knowledge. These domain-crossing objects have the potential to attract marginalized youth that have been left out of the STEM pipeline in more subtle ways by capitalizing and affirming their interests in low-tech materials while simultaneously introducing STEM content. These opportunities are especially prescient as seen against the backdrop of larger economic and political changes with dual forces of massive concentrations of media ownership and profound influences from underground and urban cultures. This type of work cultivates a citizenry that understands, through transparency of technology, not only how things work, but how to make things themselves.

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edited by Matt Ratto and Megan Boler

Today, DIY—do-it-yourself—describes more than self-taught carpentry. Social media enables DIY citizens to organize and protest in new ways (as in Egypt's "Twitter revolution" of 2011) and to repurpose corporate content (or create new user-generated content) in order to offer political counter-narratives. This book examines the usefulness and limits of DIY citizenship, exploring the diverse forms of political participation and "critical making" that have emerged in recent years. The authors and artists in this collection describe DIY citizens whose activities range from activist fan blogging and video production to knitting and the creation of community gardens.

Contributors examine DIY activism, describing new modes of civic engagement that include Harry Potter fan activism and the activities of the Yes Men. They consider DIY making in learning, culture, hacking, and the arts, including do-it-yourself media production and collaborative documentary making. They discuss DIY and design and how citizens can unlock the black box of technological infrastructures to engage and innovate open and participatory critical making. And they explore DIY and media, describing activists' efforts to remake and reimagine media and the public sphere. As these chapters make clear, DIY is characterized by its emphasis on "doing" and making rather than passive consumption. DIY citizens assume active roles as interventionists, makers, hackers, modders, and tinkerers, in pursuit of new forms of engaged and participatory democracy.

Matt Ratto is Assistant Professor and Director of the Semaphore Research Cluster and the Critical Making Lab in the Faculty of Information at the University of Toronto. Megan Boler is Professor in the Ontario Institute for Studies in Education at the University of Toronto and editor of *Digital Media and Democracy: Tactics in Hard Times* (MIT Press).

Contributors

Mike Ananny
Chris Atton
Alexandra Bal
Devan Bissonette
Megan Boler
Catherine Burwell
Red Chidgey
Andrew Clement
Negin Dahya
Suzanne de Castell
Carl DiSalvo
Kevin Driscoll
Christina Dunbar-Hester
Joseph Ferenbok
Stephanie Fisher
Miki Foster
Stephen Gilbert
Henry Jenkins
Jennifer Jenson
Yasmin B. Kafai
Ann Light
Steve Mann
Joel McKim
Brenda McPhail
Owen McSwiney
Joshua McVeigh-Schultz
Graham Meikle
Emily Rose Michaud
Kate Milberry
Michael Murphy
Jason Nolan
Kate Orton-Johnson
Kylie A. Peppler
David J. Phillips
Karen Pollock
Matt Ratto
Ian Reilly
Rosa Reitsamer
Mandy Rose
Daniela K. Rosner
Yukari Seko
Karen Louise Smith
Lana Swartz
Alex Tichine
Jennette Weber
Elke Zobl

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