CONVERSATIONS IN

Critical Making

GARNET HERTZ, EDITOR

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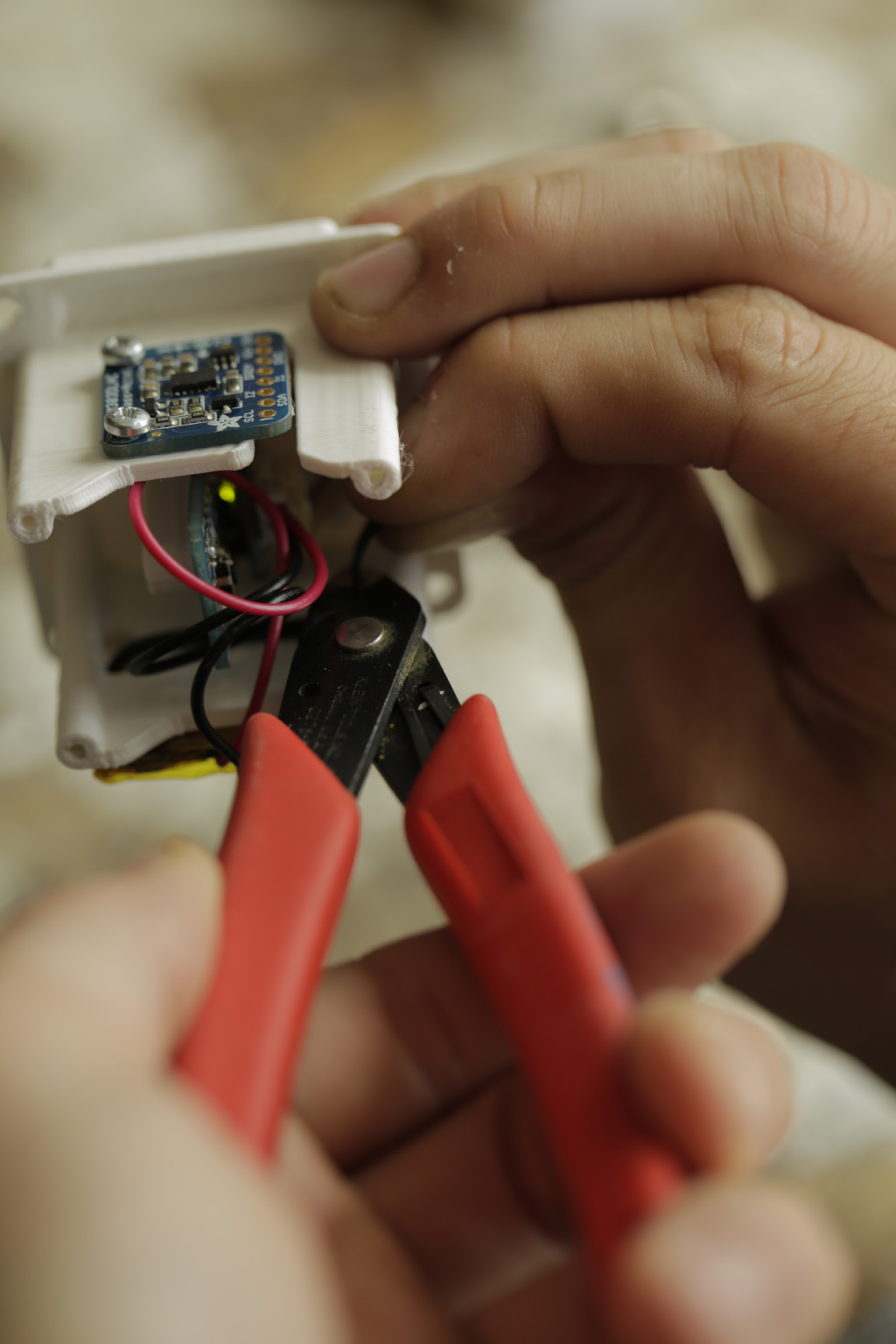
Contents



Preface

by Garnet Hertz

Critical making, as a term, was initially used by Matt Ratto in 2008 and first published in 2009 to describe the combination of critical thinking with hands-on making, a kind of pedagogical practice that uses material engagements with technologies to open up and extend critical social reflection.[1] In Ratto's words, "critical making is an elision of two typically disconnected modes of engagement in the world—'critical thinking,' often considered as abstract, explicit, linguistically based, internal and cognitively individualistic; and 'making,' typically understood as material, tacit, embodied, external and community-oriented."[2] Ratto wanted the term to act as glue between conceptual and linguistic-oriented thinking and physical and materially based making with an emphasis on introducing hands-on practice to scholars that were primarily working through language and texts, like in the fields of communication, information studies, and science and technology studies.[3]

Because of its stress on critique and expression rather than technical refinement and utility, Ratto acknowledges that critical making has similarities to the practice of "critical design," a term popularized by Anthony Dunne and Fiona Raby[4] Critical design comes from the background of industrial design and builds objects that work to challenge the narrow conventions and biases that products play in daily life, primarily those that determine that products need to be convenient, affirmative, soothing, and empowering for the user. Critical design is focused on building

industrial design prototypes that question the way products reinforce a banal and comfortable status quo by being efficient, optimized, or comfortable, and instead pushes users into more complex emotional and psychological territory by questioning social norms and stimulating discussion and criticism of design itself.[5] For example, critical designers often build products for a dystopic future, with the prototypes professionally documented and communicated through narrative video or images: "Products . . . as a special category of object, can locate these issues within a context of everyday material culture. Design today is concerned with commercial and marketing activities, but it could operate on a more intellectual level, bringing philosophical issues into an everyday context in a novel yet accessible way."[6]

A number of key differences between critical design and critical making exist, however. Critical making, as envisioned by Ratto in 2011, was much more focused on the constructive process of making as opposed to building an artifact. While critical design is focused on building refined objects to generate critique of traditional industrial design, critical making was initially conceived as a workshop framework with the final prototypes existing only as a remnant of the process[7] Critical design, on the other hand, tends to be focused on building objects that document well, and the artifacts do the work of challenging concepts like optimization, efficiency, social norms, and utopianism. Critical design is object-oriented; critical making is process-oriented and scholarship-oriented: "Critical making emphasizes the shared acts of making rather than the evocative object. The final prototypes are not intended to be displayed and to speak for themselves."[8] Ratto's emphasis is on using hands-on techniques to augment the process of critical thinking, while Dunne and Raby's critical design is primarily focused on building props for the construction of a speculative narrative.

As a process and scholarship-oriented practice, Ratto's critical making resembles values in design, a concept most closely affiliated with Helen Nissembaum.[9] Values in design is an approach to studying sociotechnical systems from the perspective of values, and starts from the assumption that technology is never neutral: "Certain design decisions enable or restrict the ways in which material objects may be used, and those decisions feed back into the myths and symbols we think are meaningful."[10] Values in design is an approach to scholarship and a workshop method that strives to unpack the assumptions behind technological designs and increase understanding in how technological objects shape social values. Although objects are at the heart of this process and scholarship, the understanding of these objects is of prime importance. Like critical making, technological objects are primarily to be studied, worked through, and understood through a value-oriented process of scholarly inquiry. Critical making explicitly names making as an important part of this process, while making is optional in the process of values in design. Critical making is like values in design, but the former clearly emphasizes the value of material production as a site for critical reflection, following the "material turn" that highlights material objects as a key part of social processes and conceptual frameworks.[11] Ratto's term of critical making is like a constructionist approach to work through values in design, information studies, or science and technology studies.[12]

My interest in the term critical making comes from a perspective of hands-on technology development and studio practice: flipping the emphasis of the hands-on augmentation of critical technology studies to appeal to "makers" to be more critically engaged with technology. In other words, I saw that the term as useful in encouraging makers—whether they are engineers, industrial designers, or technology-oriented artists—to step back and reevaluate the assumptions and values being embedded into their designs. While Ratto's emphasis is on having making

improve critical inquiry of technology, I saw critical thought about technology as improving the process of making. Along the lines of critical design, my interests are more object-oriented instead of process-oriented.

With the objective of expanding the term critical making as an appeal to hands-on makers to be more critically engaged with technology, I set out to interview a number of people on the topic of how hands-on technology development interrelates to critical theory. I also felt that Ratto was not following through with the process of making enough, and that objects had a powerful force beyond their process of creation—they could circulate as art objects, product prototypes, or visual documentation that could reach far beyond the process of development. Focusing primarily on the development process limited the reach of critically made things to challenge the wider public's understanding of the relations between society and technology. In other words, I felt that Ratto's framing of critical making as a process limited its ability to disseminate critical thought through objects. Objects are effective as things to think with, can link concepts in a different way than language can, and can have a life of their own and can travel through different contexts. Although constructed objects are often imprecise in communicating ideas in comparison to language, things have the strength to hit you powerfully and forcefully. Critically engaged language can do detailed surgery on a topic; critical objects can hit like an emotional sledgehammer. To stop short of documenting and disseminating objects that are made in a critical way cuts the audience off from the impact of things to think with.

To dig into these topics and to draw links between the related concepts of critical making, critical design, values in design, maker culture, art and technology, critical technical practice, and others, I interviewed a number of people working in these fields, including Ratto, Phoebe Sengers, Natalie Jeremijenko, Alexander R. Galloway, and Jentery Sayers. All of these individuals work at

the intersection of critical thinking and hands-on practice: Sengers develops new kinds of interactive technology that respond to and encourage critical reflection on the place of technology in culture;[13] Jeremijenko blends art, engineering, and environmentalism to create real-life experiments that enable social change;[14] Galloway is a philosopher and media theorist who also works as a programmer and artist;[15] and Sayers works in digital humanities with a "tinker-centric" approach to pedagogy.[16]

The key theme driving these conversations was to collect critical responses to the maker movement, which can be defined as a "convergence of computer hackers and traditional artisans . . . [that] tap into an American admiration for self-reliance and combine that with open-source learning, contemporary design and powerful personal technology like 3-D printers."[17] The starting point for these conversations was to take reflective stock of the DIY maker movement, which has emerged over the last decade through publications like *Make* magazine and related Maker Faire events, open-source hardware projects like the Arduino microprocessor platform, and new developments in low-cost 3D printing. Other topics include the interplay between critical theory and hands-on practice, contemporary art, the process of developing new technologies, open source hardware, tactical media and politics, interdisciplinarity and academic institutions, critical and speculative design, mass-produced consumer culture, and hackers and hackerspaces.

In conclusion, I hope that these conversations bring forward an expansion of the concept of critically engaged making, and in turn expand Ratto's term to bring critical inquiry to augment the process of hands-on practice. This is vitally important, since critically made objects have the power to be evocative "things to think with" that can be documented online, exhibited in public art galleries, or published as case studies in academic papers—and can work to expose the hidden assumptions and values embedded in

technological systems to a wide audience. Critically made objects can enable individuals to reflect on the personal and social impact of new technologies, and to provide a provocative, speculative, and rich vision of our technological future that avoids the clichés of consumerism industrial design.

Notes

1. Matt Ratto and Stephen Hockema, "Flwr Pwr: Tending the Walled Garden," in *Walled Garden*, ed. A. Dekker and A. Wolfsberger (The Netherlands: Virtueel Platform, 2009).
2. *Ibid.*
3. Ratto, "Open Design and Critical Making," in *Open Design Now: Why Design Cannot Remain Exclusive*, ed. P. Atkinson, M. Avital, B. Mau, R. Ramakers and C. Hummels (The Netherlands: BIS Publishers, 2011). http://opendesignnow.org/index.php/article/critical-making-matt-ratto/ (accessed July 16, 2015).
4. Anthony Dunne, *Hertzian tales: electronic products, aesthetic experience and critical design* (London: Royal College of Art computer related design research studio, 1999), 177; Ratto, "Open Design and Critical Making."
5. Dunne, 147; Dunne & Raby, *Critical Design FAQ*, http://www.dunneandraby.co.uk/content/bydandr/13/0 (accessed July 16, 2015).]
6. Dunne & Raby, http://www.dunneandraby.co.uk/content/bydandr/42/0 (accessed July 20, 2015).
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10. Nissenbaum, "Values in Design: What is Values in Design?," http://www.nyu.edu/projects/nissenbaum/vid/about.html (accessed July 16, 2015).
11. Dan Hicks, "The Material-Cultural Turn: Event and Effect," in *The Oxford Handbook of Material Culture Studies*, ed. Dan Hicks and Mary C. Beaudry (Oxford: Oxford University Press, 2010), 25-98.
12. Seymour Papert and Idit Harel, "Situating Constructionism," in *Constructionism*, (New York: Ablex Publishing Corporation, 1991), 193-206. Retrieved from http://www.papert.org/articles/SituatingConstructionism.html (accessed July 20, 2015).
13. See http://www.cs.cornell.edu/people/sengers/.
14. See, for example, https://www.ted.com/speakers/natalie_jeremijenko.
15. See http://cultureandcommunication.org/galloway/bio.
16. See http://www.jenterysayers.com/2012/tinkering/.
17. Joan Voight, "Which Big Brands Are Courting the Maker Movement, and Why: From Levi's to Home Depot," *Adweek* (March 17 2014), http://www.adweek.com/news/advertising-branding/which-big-brands-are-courting-maker-movement-and-why-156315 (accessed July 20, 2015).

Critical Technical Practice and Critical Making

Phoebe Sengers
in conversation with Garnet Hertz

GARNET HERTZ: How do you see the term "critical technical practice" both developing and relating to your work? How has it been loved, abandoned, taken up, or used in different ways?

PHOEBE SENGERS: Critical technical practice is one of the key terms behind my work, a key inspiration for what I do. When Phil Agre's *Computation and Human Experience* came out—it was right before I finished my PhD and I already had been doing work in the same vein—it brought together a lot of the things that I'd been thinking about. It has become really important for me. The key idea behind critical technical practice, as far as I'm concerned, is the idea that one can be critical during the process of technology building. Often we think you're either building or making things, or you're just criticizing. So to me, the power of critical technical practice is to articulate why thinking about things critically and culturally can make a difference within technical practice.

Over the course of the years I've been working with this term, one part that has become clearer and clearer to me—and I don't know how much this is in the mind of everybody who does critical technical practice—is that critical technical practice is about rhetorical formations. It's about how technology is created as a way of thinking. Critical technical practice isn't just about one individual person building something technically and then thinking critically about it—that's an important part, of course—it is also about

how ways of technology building bring in particular assumptions about the way that the world is and being able to question those assumptions in order to open up new spaces for making and new spaces for thinking about technology and people. That may or may not be an important distinction from or alignment with critical making.

Some of the kinds of references that are talked about with regard to critical making seem to be more about individuals getting a sense of personal enlightenment out of making. I think that that's a part of critical technical practice, but it's also important to think about it in terms of larger cultural institutions and formations. The reason that is important is because in the end it's about a political agenda of saying technologists are building the world—not all of the world, but a large part of it—and it is important that there be a critical voice within that practice to make sure that engineers around the world are building things that we want to have as a society or that are making the world a better place and not just a more high-tech place.

In terms of the development of the term, I'm not sure who uses the term critical technical practice. To me critical technical practice is a little bit of an insider term. There are people like me who write on computation and human experience and then there's the rest of the world that doesn't really know what we're talking about. [laughter]

GH: Right.

PS: So it's hard for me to talk about the development of the term, because it's not clear to me how it has developed beyond a pretty small inner circle of people who talk about it. And maybe you actually know better than me.

GH: I've seen the term critical technical practice used by a number of artists or people who know Phil Agre's work, but I haven't seen

it used very widely. A number of these terms—whether it's critical making, critical technical practice, or even critical design—have a lot of currency with a few people but I don't see them as being general and wide terms. I see the idea of "maker" as being quite a bit of a wider term or concept. How do you see critical technical practice in relationship to a concept like the maker movement?

PS: The answer to your question from my perspective is pretty complicated. In one sense, this idea of making and the idea of critical technical practice really go hand in hand, because one of the ideas behind critical technical practice is that your understanding of what you're doing is deeply tied in with the material practices of making these things, and this hands-on building is an important part of critical technical practice. So from that perspective I think they're quite aligned. Also, within the idea of being a maker or making is this idea of a built-in critique of consumer society as being part of what you're trying to do with making. So that again is potentially an alignment, although I don't know what Agre would say about it. For him, the critical process was more around critiquing the technology process from within, but not so much about bringing in particular kinds of political or cultural modes of critique that you wanted to bring to the technology; that's an area where critical design is quite different in its orientation. The critique of consumer society is a key element of what critical design is supposed to be.

GH: To follow up on that: What does critical technical practice have that the maker movement doesn't have?

PS: I think the key difference between the two is the focus on the maker movement on the amateur, and that has pluses and minuses. Critical technical practice is very much oriented towards critiquing and intervening in the major modes of professional technology production—trying to get engineering as a profession, both as a

kind of research area and an industrial area, to change its ways. And making is much more focused on the amateur and getting these tools into individuals' hands, and not as focused on institutional interventions and engineering as a discipline.

GH: What about the critical component of it . . . as opposed to just the amateur/DIY model versus the expert component. In what ways is the maker movement, as it is popularly known, critical? I think you mentioned consumer culture, and I'd agree with that, but can you expand on this?

PS: I have to say my understanding of critical technical practice is a lot deeper than my understanding of everything that's going on in the maker movement. I've watched it as an interested outsider but there could be a lot of things going on there that I don't know about. I think a lot of it, in terms of critique, is about raising more personal awareness that things could be different, that you can lead your life or structure your life in a different kind of way if you take making as central instead of consuming as central. And that's a dominant, critical path that's been taken in the maker movement.

I guess another way of putting it is instead of saying "expert versus amateur" would be to say "consumer versus producer." Then critical technical practice is about trying to intervene at the production level, and making is about trying to turn consumers into producers. And those certainly aren't incompatible, but they're a little bit different in emphasis. From that point of view, one thing that is quite interesting about the maker movement is a conviction in the political importance of individuals' experiences with making technology. Some interest in individual experience is implicit in critical technical practice, autobiographical things that Phil Agre would agree with, for instance, in talking about his own transformation in thinking about and experiencing technology. But the maker movement's got a big jump on critical technical practice in terms of a wide reach, in terms of being able to reach people

in a kind of personal way that critical technical practice wasn't intended to do and probably wouldn't be able to do.

GH: What do you make of Matt Ratto's term "critical making"? Do you see it as somewhere in between making and critical technical practice?

PS: I think that Matt's aim is to draw on ideas from those two realms. I've talked with Matt about this before, and I do think that in terms of the distinction between critical making and critical technical practice, that he's definitely trying to intervene in the profession of engineering, to trying to place these kinds of tools in everybody's hands. I think that's exactly the kind of interpolation that he's trying to make between those two terms. To bring in more of a critical agenda with critical technical practice, and tying that to this kind of maker—shifting consumers into producers—way of thinking.

GH: Yeah, when I've talked to him, I've seen him describe the term as aimed at Science and Technology Studies and the Humanities. I see it primarily aimed at getting the people in the humanities and information studies to think about the productive aspect of a hands-on thinking through technology—and sometimes that means electronics or media technologies—by scholars actually building things.

PS: Yeah, I've definitely seen that.

GH: It's an interesting angle and I've talked to him at some length about this: I don't see critical making as he uses the term as primarily getting engineers to be more critical.

PS: No, no. I don't think that that's his agenda.

GH: I see it more as getting critical people to think about

technology and making.

PS: Yeah.

GH: Can you describe how the fieldwork you're currently doing fits in with either the concept of critical technical practice or making or maybe critical making—or maybe it doesn't fit with that—and can you give an overview of what you're working on and how it relates to those concepts?

PS: What I've been working on for the last couple of years is an ethnographic and historical field study in Change Islands, a small Newfoundland fishing village which, up until fairly recently, has lived a very traditional lifestyle. Since the 60s, they've undergone rapid technological transformation. So, in the 60s, they had no running water, no electricity, no telephone, no TV, no roads, no transportation off the island in the winter. And now they've got broadband Internet and everything.

I've been talking a lot to the people there about the changes they've seen over the course of their lives with the introduction of these technologies. And as you might imagine, living in a remote community on the coast of Newfoundland, well, they do a lot of making. Consumer goods aren't so easy to get hold of and you make do a lot and you make a lot of stuff yourself. Of course, that's changed over the course of modernization; now there's a lot of car transportation; it's much easier to go off the island to go to the Walmart two hours away and go shopping there. But, still, people there do a lot of really hands-on stuff. And when I lived on that island, I ended up doing a lot of making-do and making things myself, just because it was easier. So, that was also a new experience—to realize how much more intricately tied into the world of consumer goods I was than I thought.

Another aspect that has become clear on Change Islands is that

making is not only about making end products—making a boat, making socks—but also about making infrastructure, things like plumbing, electricity, heating. Many of the infrastructures people have were cobbled together over time by homeowners, not by professionals. When people move to Change Islands from the city, where they expect such infrastructures to work seamlessly and be essentially invisible, this can be a shock. It makes you realize how much of the made world is out of view, even if you see yourself as a "maker."

A key aspect of the Change Islands community is that it is working-class, and that involves a different kind of perspective on making and on what we might call "manual labor" than was typical in the urban, educated communities I had been used to living in before I came to the islands. Making is taken for granted as something you do to be alive, as opposed to an exotic, specialized activity. In terms of making and all the other questions that you were asking, I wonder about the class issues that are tied to the maker movement. I wonder whether making, and to what extent critical making, becomes a kind of elite activity that only a few people can do and whether, and to what extent, it ties to the already widely existing making practices that exist among people who are blue collar. Are those people part of the maker movement? I don't know if they are or if they aren't.

GH: A market research study done by Intel for *Make* magazine in 2012 sheds some light on this. They did a study of several hundred online respondents that had either subscribed to *Make* magazine or gone to Maker Faire. The median income was $106,000 per year, and 8 out 10 respondents were male. I had sort of assumed that that would be the case but I hadn't seen any questionnaires or information about that . . . so I think that you are right in that the maker movement isn't really a blue collar type of thing and is not a rural thing.

I've briefly written about spending time growing up on a rural farm in Canada, and I don't think it has the exact dynamic as what you're dealing with in Newfoundland, but it's a place where it can be difficult to purchase things and stuff ends up just being made out of necessity. I've always felt in that way the maker movement is kind of like an elite, affluent, leisure-time kind of activity that is very different from what poor people do with technology or in developing nations. It's removed from that and the politics of class and income.

PS: I don't mean this so much as a downer on the maker movement, but I do think that there's an incredible opportunity there to think about what making actually means for many people for whom making is just a part of everyday life. A researcher in my group, Maria Håkansson, worked with Gilly Leshed on a study on farm families around Ithaca, New York, and a lot of these issues came up. The relation with technology and what they want technology to do is so different from the way that we imagine it when we're building technology for or with white-collar people who live in the city. There's a lot of opportunism, mixing old and new, and drawing on what you might consider ancient technologies to make things work today.

I think there's a huge opportunity to ask what working-class people and rural people are doing with technology. They're definitely making. Are they doing critical making? To some degree I would argue that it is inherently critical in the sense that they develop a very different relationship to what technology should or could do. We should be thinking about how that should be valued within critical making or could be folded into critical making—because if there is an important political agenda built into the maker movement, then that agenda should be made available more widely than to the cultural elite. [laughter]

GH: Yes, I think you're correct.

PS: There's also a little bit of hubris. We need to be careful not to seem like we're the first people who have invented the making of things.

GH: Right, just because you have a laser cutter and a 3D printer and an Arduino doesn't mean that you are some new generation of homesteader that's doing everything from scratch. It's kind of naïve to think that you're doing that.

PS: One of the major themes I'm looking at in my study is what happens during modernization. What happens when you modernize, how do people change, how do people's experiences change? Tom Hughes says that one big shift that comes with modernization is that you become deeply embedded in large technological systems, so that your whole life exists in interaction with these large technical systems that partly determine what you do. One shift that you can definitely see very clearly on Change Islands is over time they are getting more and more into larger technological systems that help to determine what is possible.

A simple example is getting electricity on the islands, which meant that people had to start paying regular bills. Which meant that people had to join the monetary economy, when before they had been in more of a barter economy. Which meant that people had to engage in other kinds of employment that generated wages. Which meant that it became harder to engage in a subsistence lifestyle. And so on.

One way to think about making is that it would be nice if the maker movement was one way in which we could start trying to escape some of that dominance of very large technical systems. And it's not clear to me how much high-tech making actually allows for that anymore, because you're so dependent on all the pieces of code that everybody else made and what everybody else is doing. It's not clear to me whether it's entirely achievable.

I think with people wanting to raise their own chickens, or cooking everything from scratch and raising your own food, that it's imaginable that you could achieve a declaration of independence from some of those technological systems, at least in some parts of your life. I'm not sure it's possible with that kind of Arduino set-up you were talking about. I think the problem is a lot more complicated.

GH: Something that I've been thinking of is this idea of the kludge, the physical hack where something is done maybe not in a stylish way but in quick and functional way, like using duct tape to put on your rear view mirror that fell off. In what way in these fishing villages do you see that the work is kludged or put together in a hasty or unprofessional way that maybe there is not a lot of craftsmanship to it? What ways do you see it where people take a lot of pride in these handmade or hand-built technologies?

PS: I think you see a wide range [laughter]. You definitely see kludges . . . there's no doubt about it, but you also see a lot of incredibly skilled labour. Some of it just depends on the personality of the person who's doing it, but other things depend on what the situation is. If you're building an extension on your house, then that might be different from: "oh jeez, the phone isn't working again, I'm just going to drill another hole in the wall and make a new connection", or whatever. It's hard to make universal judgments.

I do think there is a difference though in the ways that Newfoundlanders think about—or at least traditionally think about—material architecture compared to what we might consider normal or professional in urban settings. Traditional Newfoundland architecture is intentionally ephemeral, so houses are pulled apart and reassembled frequently. In traditional architecture, whole houses are moved frequently, and parts of houses are moved frequently. The architect Robert Mellin says in some ways that

building a house in Newfoundland was like building a ship: it was built on the same manual skills, and was intended as something that could move from place to place. The impermanence of physical structures is a little bit different from what we're used to in the city. And it's intended like that. You expect that if you have some kind of structure that you're going to have to basically rebuild large parts of it every ten years, and continuously maintain it to make sure it doesn't biodegrade, essentially. A big advantage of that is that when things aren't actively used any more, they disappear. And that's just the way that things are done. So to us that might look like kludge, but it's actually a natural reaction to the way the climate works there and the ways in which the houses fit into the practices that people have who are living in them.

GH: With this in mind, how do you see critical technical practice and maker culture interacting with each other?

PS: One of the strong lessons I'm learning from my current work is about the ties between the ways we organize our everyday lives and our sense of our moral place in the universe. These ties are also strong in both critical technical practice and in maker culture. In critical technical practice, there's this sense of a mission to reform engineering and technology, to radically change our methods for creating technologies and technologists in ways that will do more justice to the richness and depth of human life. Similarly, maker culture is about taking on a particular, morally charged identity—it's not "making" but "maker" culture. This identity carries a lot of ideas about how making will remake our relationships to technology and production, to literally make the world a better place. It's easy sometimes to be cynical about this, but I think it's important to respect and tap the affective power of both of these forms.

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Phoebe Sengers is a faculty member in Information Science and Science & Technology Studies at Cornell University, where she leads the Culturally Embedded Computing group. Dr. Sengers is a computer scientist and cultural theorist, working primarily in Human-Computer Interaction and cultural studies of technology. She analyzes the social and political implications of technology and proposes design alternatives. Previously, she worked at the Media Arts Research Studies group at the German National Computer Science Research Center (GMD) in Bonn, Germany and was a Fulbright Scholar at the Center for Art and Media Technology (ZKM) in Karlsruhe, Germany. In August 1998, she graduated from Carnegie Mellon University with a self-defined interdisciplinary PhD in Artificial Intelligence and Cultural Theory (administered jointly by the Department of Computer Science and the Program in Literary and Cultural Theory).

Dr. Sengers's current research focuses on two core themes: 1) working towards sustainable IT design, with awareness of the central role that computing and other technologies play in consumer culture; and 2) understanding the difference it makes in IT design to take the humanities and arts as central to our forms of knowledge production, in addition to science and engineering. A major component of her current work is a long-term design-ethnographic and historical study of sociotechnological change in the small, traditional fishing community of Change Islands, Newfoundland.

Engineering Anti-Techno-Fetishism

Natalie Jeremijenko
in conversation with Garnet Hertz

GARNET HERTZ: In your opinion, what's wrong with or how would you change the maker movement? How did you envision the maker movement and specifically *Make* magazine when it was first coming out and how it is now? Weren't you in some of the first issues?

NATALIE JEREMIJENKO: Yes—I was actually in the first couple of issues of *Make*.

When I first exhibited in the early Nineties with technology, in each and every case, I'd be developing the conceptual ideas, but all people were interested in was that I actually made these things and designed the electronics. Most of the people, most of the audience didn't even get to think about the ideas that I was trying to explore and experiment with. They were just fascinated with the fact that technology was the medium and that if I could do it then they could do it. That was the predominant reception of my work, people asking, "How did you know how to make it?" over and over again. Even with the Suicide Box in the early Nineties, the response was not so much about the phenomenon of suicide—a tragic social phenomena at a premiere suicide site in the country, the Golden Gate Bridge.

So, to get to *Make* magazine was to recognize a full monthly publication I finally felt addressed—in which we could actually talk about—how you make it and how that was part of the reimagining

about technological mud, if you will. If you think of Rich Gold's thing, making work from the mud of our riverbank. This is our cultural medium; this is the front of social change.

I hoped that *Make* could actually explore what is possible with new technology, how we could change socio-technical conditions, how we could reimagine our social environmental situations with these new technologies, which is always the question that has fascinated me.

I was really pleased when *Make* covered the feral robotic dog pack release in San Diego with the students, but they did a story on it that was fairly journalistic. Of course, they didn't write about the struggles to set up a lab that actually functioned in the space, they didn't write about the contaminants or how the contaminants got there, or the kind of political dynamics of the project—for example, how the mayor of San Diego came, how there were only five working dogs released in the class, but how there were seven television news crews, or how we released the dogs on the contaminated public site of Mission Bay, right beside this former military toxic waste dump that is leaching unknown superchemicals into a premiere leisure swimming and windsurfing area . . . and no one was talking about it.

So my complaints about *Make* magazine are, in general, my complaints about tech journalism. The reluctance of this kind of journalistic mode to explore the very rationale of the project and the environmental, social, and political context was something that I was a little bit surprised by. Somebody at *Make* magazine gives it some lip service, but it was a techno-fascination instead of redirecting the attention of these companion robots away from the plastic corporate story of these things as interactive toys—which is just balderdash—and toward the viable and interesting issue about the contaminants of the microprocessing industry. Most of the contaminated sites these dogs are exploring are the sniffing of their own butts, if you will, in a larger industrial ecology sense.

The fact that the journalistic coverage didn't go into any of the parts that I thought were interesting or important was a shock. I realized, to answer your question about the maker movement, this was a kind of techno-fetishism . . . of which I am certainly guilty. It's a wondrous engagement with new technology just because it's new technology, not because it's important or critical or that it does something. But this fascination could and should parlay into how this addresses the challenges that we are facing, how this takes the challenges of the 21st century, and give us the capacity to act on them, to explore what is possible.

That kind of bigger discussion is the raison d'être for screwing with this technology, for rejecting the corporate scripts of "Here's the user manual about how you're supposed to use things," and really exploiting the markets of scale to figure out how we might address the fact that we live in a post-industrial society. We live with over four hundred contaminants in our bodies thanks to technologies and their manufacturing processes—we're trying to figure out where and how and what to do about that. We have to think about these things, and to excise that out of the discussion . . . seems like that's the meat, that's the whole reason for doing it.

I could care less about a kind of techno-fetishism. We are faced with a climate crisis and tremendous social inequity and opportunities for technologies to really help us explore how to address things. The very agency that is part of the maker impulse and knowledge is to not only to solve problems, but to form problems . . . to think things through in interesting and diverse ways. When that's not what the maker movement is about, when it's just developing another app or kit, in summary, that's what is wrong with the maker movement. I'd like to see more about exploring distributed local energy production, or the kinds of big social issues that we're facing.

The first wave of critical making—which I think is in the crystal set radio era—it was a very politicized. The reason for engaging

with CB radios and getting your ham radio license and making your own crystal set radio was also to explore the political context: to be able to talk to somebody in Russia, make contact, and to understand who's controlling the airwaves and what they would be used for. This was all part of the necessary discussion you were pulled into when you were made your own crystal set radio: who are we listening to, and why?

I have to answer the first question about what's wrong with the maker movement and I think I made one point, the lack of critical discourse outside of the corporate imagination. Instead, the work needs to be about change, social innovation, and political innovation—just as much as it is about technological innovation. Social change has been excised from the discussion around making due to political views, and it's a tremendous, tremendous problem.

I think thinking is handiwork, which is why I use the term "thingker." We think with things. I can't make sense of the world in theoretical terms without the materiality of what actually works and the open-endedness of how others interpret, receive, and use things.

I think of making stuff as fundamentally an intellectual activity. I respect the tremendous ingenuity and resourcefulness of someone that is able to make things as much as I respect someone that is mathematically adept or can cite critical theory fluently. The material reality of the world is where we integrate the social, political, ecological, and intellectual ideas—and that's why it's so compelling to me, to this field. So, I don't want making things dumbed down. I don't want "let's teach people about electronics"—this is educational bullshit.

For example, there's not a lot of questioning what robots are, what they do, who they're made for, and how they can be made. If you look at something like robotic competitions, as an example, as this great kind of success in terms of a very celebrated model of

essentially making the geeky activity into something like a sport. If you go to one of these robotic competitions—with people cheering and yelling—it's exactly like being at a basketball game or a football game, and it is absent of any intellectual discussion about what these robots are for and why you would be doing a stupid little task of putting ping-pong balls in a net, because it's kind of a sports metaphor, not the intellectual metaphor that is actually about what is materially possible and why we make things and how they could be different. You see this kind of sports metaphor imported into robotics, and then you see the FIRST Lego League, which is one of the leagues that just drives me crazy.

The idea of introducing students to robotics through Lego drives me crazy: it is an absurd lie. It is a horrible, disgusting lie . . . incapacitating. If you were going to build anything, Lego would be the stupidest thing to build it out of, right? Its plastic things are too heavy; they don't have any of the rigidity or any of the structural things that you would actually build something out of. You're not really understanding what works and the fundamentals of engineering. Never would you really build anything out of Lego if you really wanted the form in any way. Moreover, look at the ecological consequences of these kinds of massively industrialized plastic processes. Moreover, it teaches kids, "Okay, you want a sensor, you want a motor? OK, here's a Lego sensor, here's a Lego motor." It turns you into a Lego consumer. It doesn't teach you how to spec a motor, how to spec an LED, any of the fundamentals of what a *Mouser* catalogue is, or where you would actually look it up if you really wanted to understand data sheets and if you wanted to order something to make something out of. It teaches you how to consume Lego. If there are any transferable skills from the Lego Mindstorms robotics league into useful productive innovation towards rethinking and contributing new ideas into the promising areas of mechatronics or robotics . . . you just don't get there through Mindstorms. There's a way in which the maker movement

or this kind of hands-on education or this emergence of thinking of things has been co-opted and taken by this larger corporate interest and kind of very conservative pedagogical agendas.

GH: Yes . . . that's good. Thank you.

NJ: So that should be question one of your sixteen. [laughter]

GH: One thing in particular that I wanted to follow up on from a previous conversation was your comment about open source standing in as a replacement in the maker community for criticality—I think this is an important point. I think it's fair to see open source being used as the kind of catchall idea that a project is socially engaged in some way. What are your thoughts on open source?

NJ: Well, I certainly think the open source movement is critically important to understanding the time. It's really a complex technical achievement done by programmers and geeks in a loosely coordinated way by various strategies actually challenging corporate paradigms. I think it is really interesting and important; it's necessary but not sufficient.

It enables collaboration and being able to draw on the tremendous resource of collective intelligence with many people and many ideas to improve and collaborate and conspire and coproduce. To open-source something is to greatly accelerate the amount of ideas you have available to you, but it's not the only thing that makes a project good.

Open source is a very important process and movement with wonderful theorists, but frankly, when it comes to a lot of the main and important issues, the Apache web server doesn't solve the climate crisis. It doesn't actually address many big issues.

The Manhattan Project, that's one example: a lot of smart people involved and it gets technically really interesting, but they spent

the next fifty years producing atomic weaponry. This whole idea of having a hothouse of ideas where you get really involved in a smart community thinking through hard problems by itself it doesn't always produce a good end outcome, right?

The idea of open sourcing as necessary but not sufficient . . . one example would be with cola, where I am actually working with my twelve-year-old son on the open-source cola recipe published by Cory Doctorow. Make the ingredients visible and that leads to transparency. Make your own open-source cola, tasting what it tastes like, realizing that the ingredients are all clove oil, orange oil, lemon oil, essential oils, and you don't have to put the caffeine powder that looks like cocaine, these things can be mixed and reinvented and changed. Open source only begins the process of innovation and to what extent we can change a normal hack. You want to think about hacking the food system, not just about making it open, not just about describing it with some kind of rigour or depth. It's not just creating the recipes. For me, it's the skills and capacities to make and to reevaluate foods we have developed.

GH: You mentioned the idea of hacking the system and I kind of think of that as separate from only making something. Do you see what's now termed as the maker community as only making stuff and not really involved in hacking?

NJ: No, I actually think all making is remaking, so everything is hacking. As far as if you're going to make something, you have to use what's available. So to some extent, I use the term hacking as larger than making, as opposed to hacking being a subset of making, because all design is redesign, all making is remaking.

Criticality is generative. To criticize something is to talk about how to make it better, what's wrong with it, how to change it. In order to actually begin to engage with making, remaking, or hacking something, you have to criticize it. Criticism is generative.

GH: Is the term "critical" too negative?

NJ: It does have this critical connotation, that it's just about being negative, but it is a step towards remaking. Understanding that the very idea that you can design something from scratch is a tremendous delusion. Critical evaluation of how things are currently made is what enables you to think about how it could be better and how it can change.

GH: Lets talk about universities and hackerspaces. Are universities a good place for a hackerspace? What do you see as the value of a hackerspaces, in general?

NJ: That's the interesting juxtaposition: hackerspaces inside of universities. There's a contrast between when you have a hackerspace inside a university and you are introducing hacking being what counts as pedagogy and how we learn and actually get hands-on learning as a fundamental skill with critical making as critical as critical writing or critical thinking. This idea of hackerspaces inside of universities, to me, couldn't be more important, particularly in engineering.

A hundred years ago when engineering first got to be less about the guy who was running the engine, a tradesperson who had low status, low compensation, and they got engineering into universities, you could get a PhD in Engineering. That was done through actually changing engineering, which of course is the profession legitimately about making stuff, and this was done by taking it out of the shop, out of the machine shops, out of the wood shops and into math classes, and into problem sets. You can spend an entire engineering education without having to make stuff—I went into engineering because I wanted to make stuff.

My career as an academic has been largely spent on figuring out how to actually put hands-on education back into the curriculum.

It is not sufficient to only discuss important theorists, but you actually really have to make stuff, really engage what it means to make stuff and who makes stuff and why it is difficult to make stuff.

Walking into a hackerspace is almost like walking into the Stanford shop, where there's a lot of people doing a lot of different projects with a collective set of equipment and an investment in facilities that makes these activities possible. It's a business model; it feels like the Stanford shop, but off campus, just a few blocks away, and you have to pay membership for it. By taking it out of the intellectual context, you obviously lose the intellectual context which I would argue is critically important for this thingking— and that thinking is done with hands, and that thinking is handwork.

GH: Let's discuss critical design within the context of critical making. What useful things can be taken from the concept of critical design, as presented by Fiona Raby and Tony Dunne?

NJ: I'm a tremendous supporter of Fiona and Tony's work in producing dystopic predictions of technology and the market. I think these predictions are worth contemplating. This type of dystopic prediction can be achieved—and is often best achieved—by producing a video and not necessarily making a prototype. In my opinion, making a robust prototype actually gets you to understand what's working and what's not working because it can be put in an open-ended way in the hands of people. Producing a video that creates a fictional scenario provides an intellectual context for debate and discussion about how we use things in which technology can play an important role, but I think it's certainly not the only way that good critical design gets done. I emphasize that it is necessary but not sufficient to have dystopic ideas.

I have a belief in diverse and atypical types of engineers: women, people not willing to work for the military, or people who aren't

seduced by the corporate Jonathan Ive-type of superhero icon. In order to understand how things can be better, it's important to gain a perspective on how things are made, who makes them under what conditions, and what the environmental costs are. We should have designers from diverse backgrounds, and actually have honest, believable experiments in what is desirable, not only what is less desirable. It's another thing creating technology, and that's where critical making takes us.

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Defining Critical Making

Matt Ratto
in conversation with Garnet Hertz

GARNET HERTZ: So, how did you initially come up with the term "critical making"?

MATT RATTO: For a few years I had been exploring the relations between sociality and technical systems, using a variety of material semiotic theories and people like Haraway and Latour as starting points. I was finding it difficult to articulate truly critical positions and engage with the social thought of philosophers like Heidegger or the scholars from the Frankfurt school within my studies. I had a sense that this difficulty was somehow related to a kind of linguistic bias that I was surprised to find within material semiotic theories. I was trying to come up with some evidence for that linguistic bias and it evolved into creating a research program through which I could constitute another way of studying technology.

I was thinking one day and thought: "critical making"—that sounds so weird, it's a very odd convergence of two words. That got me thinking, why was it that critical thinking as a phrase sounded so normal and common-sensical but critical making sounded so odd? So that was the starting point and really, my work on critical making has been primarily to try to figure out the conceptual distance between critical thinking and critical making.

GH: The starting point has to do with what we count as critical?

MR: Yes, exactly. My reasoning is basically this: most people

consider thinking a linguistic practice—an internal monologue in which we use conceptual categories to make sense of the world around us. Similarly, we tend to think of criticality as a particular form of thinking, one in which we pause to reflect, and step briefly away from action in the world in order to reason and consider these actions. Therefore, the activity of being critical is mainly thought of as one bound up in language and to some degree outside the actual world. Critical thinking as it is theorized and as it is taught is first and foremost a linguistic practice.

However, when we think of making we have a tendency to consider it as the opposite of thinking, and to consider it a form of habitual or rule-following behaviour. Making, in this light, looks a bit like assembling something from Ikea—put this piece here, cut this out, nail this together. There is a strong tendency to consider making as aconceptual and programmatic.

So this is the source of the cognitive dissonance that one feels where hearing the phrase "critical making"—critical we see as conceptual, and making is seen as not conceptual—there is a kind of lacuna between those two terms. But that's obviously quite strange if you're at all a maker, of course, because making is a deeply conceptual activity, and deeply reflexive . . . though not necessarily in the same way as critical thinking. So, critical making for me, in the beginning, was an attempt to figure out why making is considered by many to be a noncritical activity and starting from there to find ways to recover, study, and teach the criticality of making.

GH: That makes sense. At the time you had come up with that term, was it also partially a response to *Make* magazine or was this more a response to critical theory?

MR: Both, in a sense. I was aware of *Make* and the maker movement more generally, and saw the work being done under

these labels as enabling conditions for what I wanted to do. But my work was really a response to critical technical practice and, to a lesser degree, critical design. I like the work that uses those labels, but wanted to focus more explicitly on linking material modes of engagement and critical reflection on our technical environments. My goal was to explore actual making practices and to try and come up with ways to link deep reflection and critical theory within technical activities.

It's important to see the origins of the term "critical" in "critical making" as coming from the notion of critical scholarship defined by Frankfurt School scholars such as Adorno and Benjamin. Central to their work was the idea that criticality entailed not just reflection but also intervention in society. I was talking about this from a very academic perspective because when I was first talking and thinking about this, my goal was to create innovative scholarly practice. I wasn't thinking about critical making as a more general form of social engagement. But this was back in 2007—I now see a lot more connections with some of the things that you and I have talked about before, like tactical media and other forms of material intervention. I now see critical making as a more general practice than just something academics do. Critical making as a larger category allows us to connect up a variety of practices and see them in some sense as similar, like design practice, art practice, tactical media practice, academic practice, or engineering practice. Critical making can become a kind of a common hub that a whole set of material interventions can circulate through.

GH: I see the term of relevance to people who are making projects who come from the art world, activist world, even the designer world, like the critical design angle, like Dunne & Raby. They are disenfranchised or are questioning the agenda of *Make* magazine and an apolitical, gee-whiz kind of perspective that it tends to bring to developing things. That's where I see people responding to the term of critical making—where they were already doing this

style of experimental hacking or electro-mechanical studio work under the banner of electronic art. In the process of co-opting and popularizing this mode of production, *Make* thoroughly sanitized it and removed it from the streets and smoothed out its tactical or controversial edges. Critical making can be seen as re-introducing some critical edge into the maker movement, I think.

MR: Yeah, I have a bit of a distant relationship to the maker movement for some of the reasons you just stated. Like many technologically inflected movements, it has a tendency to be fearful of politics or, really, of being seen as political which is a bit of a different thing. But it's important to recognize that a lot of the development in toolsets, technologies and communities has come out of a great groundswell of interest in material practice. Whether it is knitting, or electronics, or 3D design and printing, or any other types of making, it serves as an important ground for a more critical material practice than what has previously existed.

I have to say it wasn't until very recently, in part through some of our previous conversations, that I started to really think about the sanitization of making you just described. I did note that the maker movement struggled with being political, in the same way the free/libre/open-source software movement did before it. And I do wonder if we will end up in the same place. I mean, how many people know about the history of the terms free software and open-source, and the fierce debates that accompanied those terms? Heck, I saw a fist fight break out at the 2002 Open Source Convention in San Diego. But the maker movement seems to care much less about these issues and almost ready to discard any sense of making as a form of social critique.

It has been interesting to see how what is considered "making" has changed as it has become a more dominant cultural activity. What is incorporated under that term has certainly broadened to encompass a wealth of activities—community gardening, knit

bombing, organizational work—much more than just technical objects. Some of these various activities are addressed in *DIY Citizenship: Critical Making and Social Media*, edited by Megan Boler and myself. In it, you can certainly see that some people really want to highlight the political and conceptual attributes of their work and move beyond being considered a maker. Natalie Jermijenko, for instance, whom we both know, told me that she really liked the term "critical maker." I think she wants that label "critical" because her work is obviously critical. It's not just maker work. Though others might see her work and say, "she's a maker," and leave out the critical component. Just as an example of that, people might look at her "One Tree" project and say "oh look, she made these clones of trees. Isn't it interesting that she was able to clone these trees?" And by focusing on the technical task—as interesting and difficult as it probably was—they completely miss the point that Natalie's work serves as a way of making material relations between genetics and environments, plus many issues concerned with environmental sensitivity and so forth. To think of "One Tree" as maker work and ignore the critical statements that are being made is to sanitize the work.

GH: Agreed. So how do you see critical making in relation to something like critical technical practice? Is critical technical practice historically coming out more from technology and engineering side? Is critical making as you've defined it as coming from more of a scholarly angle?

MR: I think there are a lot of similarities in all these terms—critical making, critical design, critical technical practice, participatory design, and so forth. They all emphasize forms of material engagements as important processes for social intervention. But in my conception of critical making—and I should say that I am not of course the only person who gets to define that phrase—but in my conception of it, I think critical making differs from the others

in its broader focus on the lived experience of making and the role this plays in deepening our understanding of the socio-technical environment.

I'm turning these other practices into straw men in saying this—so take it with a grain of salt—but I do see the other practices as focusing in on improving technologies by uncovering nascent values, bringing relevant stakeholders into the design process, or by showing alternatives. I've never really thought of critical making as being about the final object, about making functional technologies at all. Instead, I see critical making as first and foremost as a way of learning and exploring the world.

GH: Critical design, as one example, is quite clearly targeted towards product design. That is its strength and weakness: it's very much focused on a critique of affirmative product design, but as a result of its focus it often doesn't go beyond that.

MR: That's right. I think of critical making as broader than critical design. With critical design, there is an object that sits out in the world, and, through our witnessing of it some critical reflections of the designer are revealed to us, the observers.

Critical making, I think, is more focused on process than on that final result. In my own critical making practices, I actually create a bit of a firewall between the object that is created and the process. I've resisted doing things like exhibiting the objects that emerge from critical making courses and workshops, mainly because I'm not quite sure how to stop the idea of exhibiting from overly structuring what we do as we go through a practice of critical making. I assume that this is something that good artists and designers figure out how to do. But for me, personally, because I don't know how to ignore that reality, I worry—I've been worried—that thinking too much about finality and display would reduce participants ability to explore, learn, and reflect.

But, that being said, I do think that critical making is the first step to then doing these further steps, which have to actually do with improving the status of our environment. But critical making could reveal an insight that is not captured in the final object. In fact, I'm sure of this, and I've seen instance where, through critical making, participants come to understandings that really do not get embodied in or even connected to any kind of final object that could move outside of the context of that original making.

GH: But isn't it important to disseminate the projects that people make? It seems limiting if you are only interested in—for lack of a better term—the workshop component. I do understand the hesitation to go into the art scene and exhibit these projects as sacred things apart from the activity of making them. But how does one disseminate the work of critical making? Do you host a bunch of workshops, or how does the work spread?

From my perspective making a project is a process where knowledge resides in the thing, like a blunt, powerful, and legible mode of knowledge production. In an art context you're able to display that object and perform with it in a festival or an exhibition.

What's your key hesitation with the art world? Or is it just that you haven't really worked in that field before?

MR: No, I've never worked in the context of art. And in my naïve understanding of it, at least when I first started doing these activities, I saw art and design objects being seen as having value because they were considered novel, or innovative, or aesthetically pleasing, or similar valuations. Just as I want to avoid the normative values associated with technologies from engineering perspectives—values of labour-saving, rationalization, instrumentalism—I also want to avoid the judging of critical making objects through the lens of novelty and aesthetics. Not that either of these types of valuations are necessarily bad when applied in the right context,

but I do find them overly limited for the kinds of deep, materially mediated reflections I want to do. I wanted to make sure, for myself and for others that I was shepherding through the process, that our focus didn't shift, that we didn't get captured by the traditional ways of valuing the objects that we are making.

And again, this has all been a process: figuring out what it means to make critically. There are a couple of commitments that I made to myself when I first started this and one of the first was that it had to involve a material engagement—there needed to be an engagement within the process of critical making where the material substrate that you were working with helped to determine the final form of whatever you were making. In other words, that the world pushed back on your own thoughts of what the world could be. So it couldn't be a purely imaginative or, as Tim Ingold puts it, a purely hylomorphic practice. That was the first commitment. And the second one was that any engagement with the objects of critical making had to remain an active engagement of shaping and production. This means that rather than creating passive moments whereby people would experience the objects that others had made, there had to be a way to construct an engagement between the person coming to that object and the object itself that was real, that actually was transformative for the object as well as the person.

GH: Sure. I see that what you're describing right now having a resonance in with some contemporary art or movements like Fluxus and other action-oriented, process-oriented type of processes.

MR: Or even like happenings, right? I mean, in some ways I think of happenings as almost more the kind of model, or the kind of games the surrealists used to play. In some sense that's the kind of way that I've been thinking of the events.

GH: Or Situationism.

MR: Absolutely. I haven't really explored those connections, but have been focusing instead on the more pragmatic details of it all. I guess you could say that my most important critical making is the making of critical making. I still feel that it would be hubris to link the often quite mundane work I do with terms such as art or design. I just didn't think that critical making would be a label that would resonate for artists and designers. Though in many ways what I've been doing is appropriating the practices of artists and designers as well as those of engineering.

GH: Sure. I think that the term has become more relevant now that a number of undergraduate students in university that are very interested in the maker movement, and they have gone through the introductory steps of "being a maker": they have an Arduino that they've maybe made an LED blink with, they perhaps have been to Maker Faire, perhaps worked a bit with 3D printing and they feel like they belong. And I think a lot of individuals or faculty members that have been doing this type of work for decades kind of shake their heads and go, "OK, well that's great that you can make an LED blink, but let's try to think about some bigger issues in society or culture." I see the term being of relevance for situations like that.

MR: For me, that's very exciting, and makes me a little nervous as well. When I was just off in my little world, doing my little critical making stuff, I really felt that I could push the scholarly and conceptual part a little further in creating a new academic form that takes the idea of material semiotics seriously. Many scholars hold to the notion that the world is both simultaneously a real material thing out there that resists our ability to control and describe it, as well as something that is deeply semiotic, deeply the result of our conceptualizations. And everyone tried to theorize their way to an understanding of this—the interfiliation of the social and the natural, the agency of objects, the information of

our built environments. But I wanted the materials of the world, the things and objects we engage with, to not only be present in these arguments as linguistic artifacts, as textual doppelgangers so to speak, but to exist as key elements of our working thoughts. Most importantly, I've wanted to create a way of working in which the materials of the world are a necessary part of critical scholarly work. And it remains fascinating to me how few scholars truly engage with these materials when it comes to social and humanities study of technology.

GH: Sure, of course. I've had a similar reaction being through a PhD in film and media studies, and new media studies with people who have never touched any sort of computer programming language. It struck me as very odd, that it's a completely valid argument to say that if you're studying Foucault that you need to understand French, but if you're studying new media art or technology, that you don't need to know how to program. And I think there have been a lot of other people, like Alex Galloway or others that have argued this perspective. It's a bit along the lines of Kittler and media materialism to find importance in a deep understanding of the technologies that one studies.

MR: That is in fact one of the most interesting questions that emerges from this work—what counts as a deep understanding? The kind of critical making that I've been describing really troubles easy definitions of deep understanding—pure technical knowledge isn't enough, it's not just about getting close to the machine in Tracy Kidder's sense. You also need to have an understanding of the kind of ways that the materials might impact or relate to or engage with or co-construct the kind of social reality that we live in. You need to have an understanding that includes deeply technical as well as deeply social knowledge.

GH: There are always deeper levels within any technology. Take

computing for example: do you need to know how to use Scratch, do you need to know how to use C++, or do you need to know how to use Assembly? There are always lower levels of any technology. Do you need to know how logic works in a microprocessor? A problem in media materialism is the issue of how low should you go . . . and where does it end? This process eventually terminates in people digging in the dirt for metal, a bit like Thomas Thwaites's *Toaster* project.

MR: Exactly. Do you need to know how a computer works? Do you need to know how binary data is encoded on the hard drive? Do you need to know how to write the microcode that powers the processor at the heart of the system? Do you need to know how to build a computer? Do you need to know how functional programming languages work? So the problem here is to decide where it ends. In his book *Designing Engineers*, Louis Bucciarelli tells this great story about being at a conference where people are bemoaning the state of technical knowledge in the US, saying that no one knows how their phone works. But then he started to think about it, himself, as a trained engineer, "do I know how a phone works?" And he goes down the rabbit hole—do I know how to *use* a phone? Do I know how the signal is encoded on a phone? Do I know how the switching gets done at the switching station? Do I know the political-economic decisions that have been made that allow this carrier to have X geographic area over this carrier that has a different geographic area? And so forth and so on. One of the things that he realized was that when you start thinking about what ones needs the know, the line between social knowledge and technical knowledge gets increasingly blurry.

GH: Sure, and what about somebody saying that inside each of these black boxes of technology that there are hundreds of "PhDs" of knowledge and there's a lot of black boxes inside other black boxes. Is it even feasible to think that everybody needs

to understand everything? Or how many black boxes can you practically open? And furthermore, how does this process fit this into an educational institution, and how much should you expect a person to know? What's feasible and where's the payoff in terms of having a deeper understanding of technology?

MR: Yeah, I completely agree. And there's a tradeoff here too, in that opening the black boxes of certain things doesn't necessarily help you use them, and in fact it might make it harder for you to use them. The kind of naturalization of technology that allows us to use them more efficiently, for example, means that we don't want to be constantly conceptualizing and focusing on a deep understanding of our technological environment. You know, if you had to think through the process of how you go about shifting a manual transmission car every time you pushed on the clutch, you'd never go anywhere; it'd be too hard. So there is a kind of need to make invisible the mediation of our technological environments, depending on what we're up to, what we're engaging with at that point.

I don't think that there's a single answer to the question of how much one needs to know. That's the main focus of the book I'm working on right now. I'm trying to develop an object relational framework to allow me to say, "these are the attributes to the technological objects that are important for this type of question." So if you're looking at how individuals use this object, then these are the material attributes that you might want to look at. If you're interested in understanding it from a cultural perspective, then these are some of the attributes that you might like to look at. And if you're looking at it from an institutional perspective, then these are some of the ones that you might like to look at. To tell you the truth, looking at any of those three aspects that I just mentioned is often pretty banal. And not particularly evocative in terms of our understanding of the socio-technical world. The really interesting questions start to emerge when we address the contradictions

between social forms. How the attributes of an object that afford a particular individual use of it are in direct contradiction with attributes that make it institutionally acceptable, for example. And all you'd have to do is look at something like an MP3 file to start to unpack what that looks like. This starts to get into the reality of tactical media and the other practices we were mentioning earlier.

GH: Right, I think of critical making as coming from tactical media or the arts as emphasizing the thing that you've made as an object to intervene in social, cultural space. This sort of side steps the whole problem of how many black boxes you have to unravel to really know something. You need to unpack the black boxes and understand the technology enough to make your object so that you can put it out there and that a statement can be made through the object. I see that if too much focus is on just the process of unraveling the black boxes or understanding the technology it results in people learning binary, or going very "low" down which is only really useful if it's targeted in a specific direction. The lowness of technology never stops.

MR: I think the more scholarly project of critical making is an attempt to scope out some of these dimensions, to better frame what one needs to know and when. It also emphasizes—and I think this is pretty important—that not all the knowledge is technical in the true engineering sense, but also involves perspectives that derive from social science and humanities scholarship.

GH: Yeah, I mean, there's another perspective on this angle that asks why do you need to wrap up all these issues in one person, and why does one person need to unravel this? Why can't there just be artists that make projects and cultural theorists that analyze those objects? What's the importance, or what do you get out of combining those things into one?

MR: I think the most important issue here is to consider what

is lost and what is gained when these roles are separated. One way to consider this is to think about how you, Garnet, feel about other people's descriptions and theorizations of your work, how evocative those writings have been in terms of what you intended or the value you saw in the object you've made.

GH: And most of the time, it's terrible. And I think that many artists get into theory out of being frustrated at having their work misrepresented.

MR: They dislike or disagree with the stories that others are telling about their work and they want to do their own conceptualization. So one benefit of bringing those two identities together would be to say, "that's an individual then who has a deep ability to conceptualize their work and to then articulate those conceptualizations in a variety of ways, including linguistic forms." Because we do have to remember that part of what is going on here is that those commentators are skilled makers of their own. They're skilled makers in language, or not skilled, depending on who they are. But that's their domain; that is, in some sense, their domain of expertise. So, bringing the identities together is not necessary saying, "oh, now the artists need to conceptualize their works better." I think artists have always done that. It's about articulating those conceptualizations through a different material forms than most of them are used to working in, which is really the materials of language, or, to be more restrictive, the materials of scholarly or art criticism language.

But I think the question of the deep knowledge thing is really an important one and one of the reasons why I like critical making and not just making. Within the maker identity, as it is increasingly being performed by *Make* magazine and other venues, there's definitely a focus on technical knowledge, on people becoming as close to an engineer as they can get. I do think the process of training that I have seen articulated in *Make* often socializes

people into particular ways of thinking about the way technologies work and work in society. Technologies are made for a function; they're made to solve a problem. And although I don't think the artists follow such instrumental views on technology, the makers and the maker movement definitely has that in it, and I think it is something that should be a bit resisted.

GH: So do you see this following through in things like DARPA funding *Make* magazine? That would tend to back up what you've just said how there's a normalization happening in the maker community.

MR: Yeah, absolutely. Think about the notion of the post-optimal object from Tony Dunne. So what the hell is DARPA going to do with a bunch of post-optimal objects? I mean, that's not going to solve any of their problems. The real driver here is to create these nice "STEM-educated" bodies that will fit nicely into the—not to be too old-fashioned—so-called military industrial academic complex. Certainly the DARPA move is a great example of that. It's not mainly about military power; it's actually about maintaining a kind of a work force. That's the aspect that I am the most uncomfortable with. The idea that the maker movement becomes a nice feeder for a technical workforce that the powers-that-be in North America see as no longer providing. It's not just that *Make*-DARPA guys are going to go make bombs. It's the slotting into an industrial machine that has me worried.

GH: I see it as a fear of Chinese industrial culture eclipsing the United States. I see it very clearly as an anti-made-in-China mentality. And I think it is pitched exactly that way by *Make* magazine to the White House. And I think it's true that North America has generally forgotten how to manufacture things. People rarely pull engines out of their cars, hot rod them, or even change the oil in their vehicles anymore. There's a real forgetting of material making

that has happened in North America over the last several decades, partially at the hands of the dot com boom and the spread of the internet.

In university I think students are interested in making because it's novel. I like walking into an undergrad class and giving them a lump of play dough on their desk and just saying, "OK, make something." Physically building things is novel in many educational settings. It can be a very immersive type of thing, and I think that *Make* magazine has very cleverly capitalized on this.

MR: I think you're right. For me the main goal of making, whether critical making or whatever you want to call it, is to reconnect people to the world. The most powerful aspect of making is the way it denaturalizes the built environment. Being a maker basically gets people to look around them, to look around their world, and say, "OK, somebody made this." This thing, this object didn't just fall from heaven; somebody made this, they made decisions about it, they made choices about it and those choices are impacting me. And then the next step is recognize those choices as political, as benefitting some people over others. And the final step is for people to find some agency in regards to this political nature of the built environment. That for me is the ultimate goal of making. Which is why depoliticizing the maker movement is so problematic. An apolitical maker movement then requires that the objects that are made are equally apolitical.

GH: Yes, in terms of where the minerals are mined to make a device, how it was manufactured, where it goes after it becomes obsolete: much of this is stripped away in terms of how it is represented through *Make* magazine. It is often only communicated in terms of what functions it can do.

MR: Right. Part of what needs to happen is that people need to be aware of the tradeoffs that occur in making things. Sometimes

these tradeoffs have to do with the environment, as in the rare-earth example you just mentioned. Other times the tradeoffs have more to do with social life. We have to be able to say, "okay, well they chose a certain screen size which makes it appropriate for a particular user group and probably quite inappropriate for another user group." Ultimately, people need to understand the ways our social and natural environments are mediated through the choice-making that is part of the process of making. I think that is the most important thing that critical making should do—other than all the scholastic stuff that I'm interested in—it should help people see our environment as a made environment, made in particular interests, and serving particular interests. So to depoliticize it is to ruin this opportunity. Cleansing making of its politics takes away this amazing opportunity to better understand and exist in the world. It turns the making movement into just another way to create an industrial workforce.

GH: Or just another sort of prosumer or consumer-type group of people who now all buy open-source hardware that they could maybe assemble on their own but they're too lazy to make something neat out of.

MR: Yeah, the prosumer thing is a great example, as is user-generated content. I mean, basically a lot of the *Make* stuff that I've seen coming out is basically the material equivalent to user-generated content. It's all so heavily constrained, that it basically provides the illusion of choice. Which is what we get when we go to Burger King, where they say "have it your way," (if they're still saying that). "Have it your way." That means you can choose whether or not you can have pickles on it. But in the end, it's still a hamburger, right? So, you know, often times the prosumer thing is just a way of giving us the illusion of agency, in relationship to our built environment, but providing us so very little true choice.

GH: Okay, let's move into you discussing what you have in your critical making lab. So let's talk about this in concrete terms, in terms of what sort of equipment, what sort of social structure, what sort of instructional methods. Let's talk about how you have made a critical making lab within a university.

MR: Okay, so that's a really interesting question from an institutional perspective. First and foremost, this has been a very odd process, in some cases difficult, in some case surprisingly easy. I am lucky to work in the Faculty of Information at the University of Toronto, which is somewhat of a hybrid place. There is some technical work going on within the faculty, but it is also deeply embedded in a kind of humanistic, interpretive social sciences frame. This creates the perfect context for critical making, since it requires both technical and conceptual resources. There are aspects of this that do remain tricky; for instance, I have a laser cutter that I keep moving around campus since it requires external ventilation and my lab does not have access to this. I am in fact located in a library—the main Robarts Library at the University of Toronto—and this does reduce the kinds of equipment I can have online. Equally, being seen as a technical practice can encourage both students and other faculty to see what we do from that frame. So we kind of ride the wave between being a cultural, humanistic space and a technical space.

GH: What sort of equipment do you currently have in your lab and what direction are you planning on going with it?

MR: My current research focus is on the rubbing together of digital and physical worlds. Most of the critical making that I do in my lab and with students involves making wearable or environmental computing prototypes and using these to explore critical information issues. Therefore, we work a lot of microcontrollers like the Arduino, LilyPad, or JeeNode platforms.

We have a pretty complete electronics lab, with components and equipment directed towards both prototyping and, increasingly, fabrication. We just received an LPKF S63, which is a PCB mill, in order to play with creating our PCBs on the fly. We also do a fair amount of enclosures, or small mechanical structures, so we have a couple of proprietary 3D printers—a Dimension SST 1200 and an Objet30 Pro, a couple of Makerbots, and a Sherline CNC Mill. Probably the equipment that is used the most, other than the soldering irons, is our Versa VLS3.50 laser cutter.

We've sort of upped the ante with our current equipment since we've been moving into high-end capabilities, like with the Objet30 printer. But I do want our main focus to stay on the process side—in other words to continue to be focused on exploring the materials of production through making as an important part of critical scholarly work.

GH: Where would you like to take the idea of critical making and what do you see ahead for either the term, your own work, or maker culture? Where do you want to go with this?

MR: I think it is a kind of egomaniacal craziness to pretend to own a term like critical making. It is however a very successful academic model—whoever becomes seen as the original definer of biopolitics or boundary object or whatever gets widely cited. I do hope that my work continues to grow in relevance and that others read it and see it as a stepping stone to their own endeavours. But ultimately, I believe lots of people will engage with critical making from their own viewpoint.

I will continue to work on pragmatic and theoretical frameworks to support such work. Critical making names a mode of engagement in the world that is about seeing and making a world that has somewhat different characteristics from the world that we live in now. I know this is old-fashioned to say, but critical theory spoke

specifically of scholarly work that intervened in the world in ways that were emancipatory, ways that were freeing, that actually freed up people from these dominant social structures that theorists, artists, and advocates saw as problematic. My worry about making is that it will lose its relevance and its alterity as it becomes more mainstream. I am glad to see more people making since I think practices of engaging materially—whether knitting or building a deck or programming an Arduino—help us all see the constructed nature of our physical environments. But I think this work has to be connected to deeper analyses about why the constructed world is as it is. Without such analyses, making runs the risk of just reproducing the environments and constraints we already face.

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Matt Ratto is an Associate Professor in the Faculty of Information at the University of Toronto and directs the Semaphore Research cluster on Inclusive Design, Mobile and Pervasive Computing and, as part of Semaphore, the Critical Making Lab. His work explores the intersections between digital technologies and the human life world, with a particular focus on new developments that trouble the divide between online and offline modes of production. Ratto is an avowed expert on 3D printing and digital fabrication, having carried out research on this topic since 2009. His research also addresses pervasive and ubiquitous technologies including wearable computing and the Internet of Things.

His work crosses both the boundaries between the digital and physical world and the divide between humanities and engineering disciplines. He coined the term "critical making" in 2007 to describe work that combines humanities insights and engineering practices, and has published extensively on this concept. A current project involves the development of a cost-effective software and hardware toolchain for the scanning, design, and 3D printing of lower-limb prostheses for use in the developing world. This work is being carried out in partnership with non-profit CBM Canada, CoRSU hospital in Uganda, Autodesk Inc., and Toronto prosthetics and orthotics experts.

Humanities and Critical Approaches to Technology

Jentery Sayers
in conversation with Garnet Hertz

GARNET HERTZ: How would you describe yourself and what you're currently working on at the University of Victoria?

JENTERY SAYERS: My research interests basically hover around comparative media studies. I focus primarily on the Victorian and Edwardian periods, looking at the role old media, analog media, or dead media play in the production and distribution of culture, with specific interests in sound technologies (early magnetic recording, for example).

At the University of Victoria, I teach a series of undergraduate courses in digital studies that combine areas such as computer programming, tactile media, and gaming with critical media theory. My pedagogy mixes cultural criticism with applied approaches to technologies. I also teach undergraduate courses in 20th-century U.S. fiction. At the graduate level I teach a seminar with the theme of "Arguing with Computers," which is about how to do literary and cultural studies with, through, and against computation, again from an applied perspective.

The lab I direct is called the Maker Lab, or just MLab. (We are becoming increasingly ambivalent about the term maker, but that's another story.) The MLab has two locations on campus: a prototyping site and a fabrication site. The fabrication site is quite new. We opened it in February 2015. It's located in the Visual Arts building. Across both sites we build "kits" for people to better

understand obsolete or inaccessible technologies: devices no longer at hand or designs that were never manufactured in bulk. Those of us in the MLab including Nina Belojevic, Nicole Clouston, Katherine Goertz, Shaun Macpherson, and Danielle Morgan—prototype these technologies for assembly and circulation using physical computing and fabrication techniques, such as computer-aided milling, routing, and cutting.

GH: It's a curious overlap you have between historical work that you're doing in comparative media and English and then this stuff that you could term as maker culture. How do you see the interplay between the hands-on stuff and the written components in your work?

JS: I mix, invert, and overlap them as much as possible. Sometimes that is quite difficult, though. One of the things I routinely consider is what people such as Wendy Chun, Matthew Kirschenbaum, and Tara McPherson have done with the relationship between conceptual treatments of media and their material particulars: how technologies were made compared with how people use and interpret them, or how (if at all) we can recover things like interface or memory over time. When prototyping things that were never manufactured or are no longer accessible, I am also able to ground my media theory a bit, even if the ground can be sketchy. Also, prototyping gives those of us in the Lab a better sense of how "this becomes that," to borrow from Matthew Fuller's *Media Ecologies*.

The archival work I do—looking at documentation, studying photographs, listening to audio, examining depictions of technologies in fiction—is also enriched by a material understanding of media composition, especially when technologists or engineers of the past pitched technologies that didn't really work or were never manufactured as implied in the documentation. Put this way,

the hands-on stuff offers as much skepticism as it does certainty. It's not like prototyping yields more access to facts than writing.

Other items we consider in the MLab are laboratory notebooks and historical experiments, to see if they would have actually manifested in ways reported. There's always some anachronism there, and there is always going to be some slippage in history. After all, you can't inhabit the world like anyone did then. That's impossible. But I still think, following Kari Kraus's work, that some speculation or conjecture about historical experiences is meaningful for media history. So that's generally how MLab research operates, pushing writing beyond process documentation, taking experimentation and speculation seriously, and seeing what sorts of arguments we can make by prototyping the past. In the last instance, I hope this approach renders persuasive media studies scholarship.

GH: Are the prototypes an endpoint of what you are doing, or do you then write about those artifacts? For example, do the artifacts exist as art or design objects? Do you exhibit the artifacts and see them as an endpoint in themselves? Or, do you typically write up a summary of you building it and working with it, with the writing informing the historical documents? How do you handle or navigate that?

JS: Even though artists work in the MLab, I certainly would not say anything we are making is art. I don't have that much confidence in the aesthetic or that much hubris. After all, I'm in the humanities, and I'm not trained in art or its foundations. However, we are considering ways that we can exhibit our work in galleries or libraries, if possible. Collaborating with artists has been very informative in this regard. Still, I don't treat any of the kits as art objects, and I think we're in a liminal period right now with the kits, figuring out where they will go.

That said, one thing that interests me is being able to think about the circulation of things such as models, schematics, and even instructions via GitHub and other online mechanisms, to see if they are picked up, repurposed by others, and work their way back into scholarship and even collections. But this is only the second year of the kits project, so we're not far enough along to anticipate any ripple effects. We'll see. Right now the aims are modest, and I rely a lot on the members of the MLab team to shape its direction.

GH: Coming out of that, what was the decision to start up a lab called the "Maker Lab"? Did it just seem like a good strategy in terms of the positioning of the university or your department? That's maybe a different topic, but I'm actually interested more in your take on the maker movement. By that I mean: *Make* magazine, Maker Faire, hackerspaces, 3D printing, Arduino, and that sort of thing. What do you make of the maker movement?

JS: So, my personal background: I was at Virginia Commonwealth University as an undergraduate. There and during high school I did a lot of work with DIY zines and punk music, playing in bands, booking shows, and running non-profit venues. That's where my familiarity with DIY grew: people making their own tactile media, cutting their own records, booking their own shows, running their own tours, publishing their own writing and illustrations for their friends. Ultimately, it wasn't about controlling the means of circulation. It was about creating with a particular audience in mind. That audience may not have been the target audience for major labels, popular presses, or what have you. Instead, people created the media they wanted to see in the world and started circulating it using the technologies at hand. Of course, this happened well before I went to university in the 1990s and 2000s, and it still happens today. For instance, my pedagogy at UVic is deeply influenced by Anna Anthropy's "zinesters" approach to

games. Among other things, Anthropy shows why we don't need big studios or industry to make videogames.

In terms of the MLab's relation as well as my own relation to *Make* proper—to *Make* the brand or to Maker Faire—it's distant. We read some of the *Make* publications; we'll occasionally look at things they are publishing about physical computing and fabrication. But we're not very interested in *Make* hobbyism, especially the "pull yourself up by your bootstraps," individualist ethos that *Make* tends to spread. We're more collectively oriented, and we are not really motivated to speak to the *Make* brand directly.

That said, there are many makerspaces and labs across the U.S. and Canada that influence us: Bethany Nowviskie's work at UVa, the Critical Media Lab at Waterloo, Kim Knight's work at UT-Dallas, Bill Turkel's work at Western, Matt Ratto's work at UToronto, your work at Emily Carr, and places like The Attic in Seattle and Double Union in San Francisco, which start with the claim that what you already know is enough to get started. Liz Henry's "The Rise of Feminist Hackerspaces" is another interesting model. I think building on personal history and experience for academic research is very important.

This position is opposed to the now ubiquitous feeling that "I have to learn programming" or "I have to learn to code in order to do 'proper' digital research." By asking people in the MLab about their backgrounds and previous work, I've learned things I would have likely never known: for instance, that Danielle is an impeccable illustrator, Shaun is a musician, Katherine does a lot of social justice work, and Nina is building interactives for local galleries. Calls for new researchers often mask or ignore personal histories that I think are incredibly relevant to what and how we research. So the MLab became a space based not on lack but on what people already know and how we can work together from there. That model and culture are what we draw from DIY, punk, zines, and materialist feminism.

GH: Right. So what's the reaction to putting a laser cutter, a CNC milling machine, 3D printers, and physical computing stuff in an English Department?

JS: My sense is positive overall. We've gotten a lot of interest from various groups on campus: we recently worked with CFUV, UVic's campus radio station, and the CFUV women's collective on a physical computing and feminist practice workshop. We've also talked quite a bit across faculties: Computer Science, English, and more generally the Humanities. We go to interdisciplinary conferences, we present our research publicly, we publish together, and my department is always supportive. Of course, we've received infrastructural and other forms of support from the Humanities Faculty and the English Department, too. We're fortunate.

The fabrication lab wouldn't have been possible without support from Visual Arts. The Faculty of Fine Arts and specifically the Department of Visual Arts partnered with us to make that space happen, the space where the laser cutter and CNC machines are. Now I can't really imagine—either in hindsight or in future terms—the MLab's research working without contributions from Visual Arts researchers. We've had at least one MFA student on our research team each year.

Again, our experience has been positive, and I think the work remains communicable even if it is idiosyncratic or marginal to what a lot of humanities researchers do. Plus, the University of Victoria has such a strong background and presence in digital humanities, with the Humanities Computing and Media Centre, the Electronic Textual Cultures Lab, and initiatives such as the Modernist Versions Project, the Map of Early Modern London, and the Digital Humanities Summer Institute, for example. In my case, Ray Siemens (in English and Computer Science) paved the way for the Lab and the courses I teach, and humanities faculty

have been very welcoming. It helps tremendously, too, to have spaces such as PACTAC and programs such as Cultural, Social, and Political Thought, which foster critical theories of media and technology.

GH: Right. That makes sense. So what do you make of the term "critical making"? I see you are familiar with the term. Do you have any thoughts on it or any relationship to other related terms, like "critical design," "reflective design," "speculative fiction," or "values in design"? Do you frame your work within any of these terms, or do you find any of these things useful? Do you have some different terms that you use to construct and position your work?

JS: I first came across that term in Matt Ratto's 2011 *Information Society* article (2011), where he combines prototyping with theory, together with interests in testing and reiterating ideas as materials. I am quite keen on the term, and I like how Matt's work isn't reducible to its objects or output. It has shaped our thinking, but critical making is not a term we necessarily use in the Lab. Our approach to design, making, and material culture emerges somewhere through the articulation of comparative media studies with science and technology studies.

For example, I cannot imagine our research functioning without some attention to boundary objects, including Bowker and Star's work in *Sorting Things Out*. That idea, how objects help us understand not only where boundaries are drawn and how differences happen but also how practices and values persist, is quite compelling to me. Ideology and sameness are generated, at least in part, through consistency in objects. So, *Sorting Things Out*, as well as Star's earlier work on zoology and museum spaces, are together a starting point for the MLab. There's also Wendy Chun's work, especially her notion of governmental technologies in Programmed Visions, looking specifically at how technologies have an architecture. They

can be studied not just as things that enable certain values; we can also consider how they're built, and how that construction produces subjects. For Chun, computers interpellate and individuate while also affording a sense of agency and freedom. Suggestive work on technologies accounts for both of these things, blending Luddism with desire and even enthusiasm, if you will.

Borrowing from digital humanities research, we've also been inspired by Kari Kraus's work on speculation, including her interests in long-term thinking, that "long now" imagination you see with Stewart Brand, Brian Eno, and others. In particular, the MLab frequently engages the relationships between objects, temporality, and memory, informed by how Kraus and others anchor their critical work in prototypes and design. For me, an important question is how to be honest about the speculative components of media history while also maintaining rigour about the material and cultural particulars. That is, I don't think speculative design is reducible to whim.

Other influences include Bethany Nowviskie's work at the Scholars' Lab, Johanna Drucker's speculative computing, and—more generally—methods where people insert themselves into the systems they're studying, instead of detaching themselves from their objects of inquiry. Here, indie game design is a compelling model. Recently, the Scholars' Lab started working with fabrication and physical computing techniques, too. I'm looking forward to seeing what they do there.

I've also been following conversations around design fiction, including Bruce Sterling's take on it. At UVic in 2016 I'm teaching a graduate seminar in design fiction, twisting the concept a little bit to render it more historical. What's the long history between writing and design? We'll be looking at the production of literary, artistic, and political movements from the late 1800s forward, with an emphasis on how ideologies or "-isms" are linked to how works are designed for paper and other media. Some of those

-isms include imagism, symbolism, futurism, Fluxus, and OuLiPo. How could these -isms be rethought today as design fictions? As experiments with form, arrangement, inscription, and narrative toward possible futures? Under what assumptions, and to what effects?

These are just a few touchpoints for the MLab, across comparative media studies and science and technology studies, and I realize that they may not always add up or comprise a "total" methodology. There are important differences between them.

GH: Right. I'm glad that you raise the idea of boundary objects because I think it's important for people to understand. What do objects have that writing doesn't? What do you, or the students that you work with, think that you gain out of getting dirt under your fingernails?

JS: Yes, that's a tough one. I think our default position would be that objects are always congealed or frozen process (echoing Marx). In the MLab, we are not interested in creating things we ultimately fetishize. We're also not interested in arguments that render objects withdrawn or unknowable. This kind of ontology doesn't fascinate us. Perhaps making objects—and here I'm thinking of Tara McPherson's work in *Cinema Journal*—prompts us to work with the media we study and use. This way, you have a better understanding of several things, including how media are situated but also change over time. In the case of the kits project, related questions are: what media worked then? What was possible, what was not, and through what value systems? How should we prototype the past using today's technologies? These questions are inspired by McPherson's call to think through, and not just about, new media.

Again, in the case of the kits, history implies well over 100 years. A lot of the research also engages the gendered social politics of the

Victorian period: for whom were these objects made? How were they meant to be used? How is innovation, for example, gendered and manifested through events such as public exhibitions and fairs? But we resist overly conceptual treatments of objects, too, by better understanding how this became that, without assuming you can ever fully comprehend the composition of a given thing. In so doing, we're not invested in the exact reproduction of history, or in re-enacting it. We're well aware of the fact that history emerges from the present, after the fact, through whatever memories we have at our disposal.

For example, one of our kits is about early wearable technologies (1860s-1880s): jewelry pieces designed by Gustave Trouvé in France and animated using electromagnetism. Through that kit we have learned a lot about what I, at least, would have likely ignored while writing an essay about early wearables. For instance, clock-making and telegraph mechanisms (the telegraph sounder, in particular) were fundamental to early wearables design. Also, an emerging electromagnetic worldview (i.e., electromagnetism could account for practically every scientific or natural phenomenon) informed how the wearables articulated technological innovation with fashion and performance. We still don't really know who wore these wearables or how popular they actually were. But we do know we cannot persuasively historicize them without attending to how bodies and technologies, or labour and media, are understood together. Early wearables design didn't happen outside gender, class, power, or race relations, and their construction wasn't effortless. And while a few scholars, including Carolyn Marvin and Susan Elizabeth Ryan, have written about them, they remain largely ignored by media studies, perhaps because we don't have them ready to hand and there's not much known about their composition, circulation, and use. In this sense, prototyping them helps us engage and even speculate about what's escaped us: the

ghosts and practices we know we'll never fully recover but were important in Victorian cultures.

Perhaps unrelated, but the other thing I should mention about prototyping tactile media in the humanities is that—and I'm not necessarily sure this is a good thing—students are frequently compelled to get the thing to function "properly." With essays, they may likely think, "Alright, I've done what I can, and I know this isn't going to be published at the end of the semester. It's good enough." Meanwhile, there's something about prototyping and design, including physical computing and programming, where they want everything to work before they submit it for assessment. Across writing and design, there are different impulses around what it means to complete something, or what it means for something to function. For me, melding the impulses together is an important pedagogical gesture.

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Critique and Making

Alexander R. Galloway
in conversation with Garnet Hertz

GARNET HERTZ: In your opinion, what do you see as being wrong with the maker movement?

ALEXANDER R. GALLOWAY: There are a lot of things right with the maker movement. Most definitely. At the same time I may have a more polemical position on this. You could view the maker movement as the last period at the end of a very long sentence. And in this sense it's less surprising, even if it brings a certain kind of shift in our culture and technology. That larger transformation has to do with how modern society has shifted since the early 1970s, how a spotlight has been shined on individuals and turned individuals into makers in a much broader sense. Our society today is founded on a new form of production that originates from individuals, from their own expression, from their own presentation, from their own performance and self promotion. A production through affect, and behaviour, and comportment. We are all makers of our own presence in the world. And we can think of this as a new productive capacity—as a lot of economists already do.

What's the similarity between Facebook and the explosion of the TED talks phenomenon, or the way video games are designed these days, or even in something like the memoir which has mushroomed as a branch of literature? These all show different facets of the same larger social phenomenon, which is that we now

focus a lot of energy on the elevation of the individual's productive capacity, its performative-expressive capacity. This would be a way to connect Joan Didion with Diablo 3. It's a kind of generalized narcissism (in a non-pejorative sense). Facebook as a narcissistic machine, etc. We are all makers of things. So, if we were to evaluate what is wrong with the maker movement, I think we cannot simply limit it to just this isolated movement; we need to think much more generally about things like Web 2.0. In sum, everyone today is a maker.

GH: So you don't view the maker movement as reverting back to handmade craft and self-sufficiency, like what was more popular in material culture maybe a hundred years ago, as in homesteading culture?

AG: That's happening, yes. We're a really rich country here in the United States, but at the same time we are completely impoverished. We're completely impoverished in our minds and in our bodies. That is why you see a turn now, as there is periodically in modern life, back to a more authentic or sincere way of living. Hence a new authentic hacker ethos where people are building things.

Look at the 1980s and the explosion of punk rock and indie punk labels. That was a similar kind of instinct. Today, everyone is a maker, but no one is really making anything. We have this sense of universality, but I'm not sure we really fulfill the promise of collectivity.

GH: I see a thread in DIY culture as gesturing toward what people were doing a hundred years ago—at least in terms of being self-sufficient, making things by hand and looking for alternatives to "Walmart culture." However, what I see in the *Make* magazine brand of making usually involve building things with Arduinos, making LEDs light up, and using 3D printers—in many ways, this seems like just of another style of technology consumer.

AG: A lot of people are interested in the idea of the so called "prosumer." That is, a consumer who is also productive and, moreover, is obligated to be productive. As you're hinting, this has a long history in American and commercial life. A hundred years ago, furniture designers, like Gustav Stickley, would send you things that you would have to assemble yourself. They were outsourcing part of their assembly labour to the consumer. And of course the larger craftsman movement also connects with DIY culture and these related topics. Maybe it's very American too; I'm not sure. We have such a strong mythology, the Emersonian myth of self-reliance and the Protestant ethic and the spirit of capitalism: pull yourself up by your bootstraps; be self-sufficient. Part of me loves all of that; I am definitely seduced by self-sufficiency and can see the appeal.

GH: Right. What is your perspective on open source? Something that was brought up to me by Natalie Jeremijenko was the idea of open-source licenses replacing or standing in for the idea of being critical or thoughtful. We had talked about it in terms of people saying "Well here's my gizmo; here's my gadget and it's open source so that means that I'm critically engaging with culture." Do you have any thoughts on open-source hardware, or how it's been developing over the last half decade?

AG: Open source is a tricky subject. On the one hand, we should acknowledge that open-source software is one of the single most important things that has happened in our time. Think of it: the idea that one of the largest corporations on the planet—Microsoft or whoever—could actually be threatened by a completely self-organizing, open-source project. It's marvellous to contemplate. And sometimes not simply threatened but bested—look at the Apache server and its historical dominance in the web server market. As a thought experiment, imagine if there were an all-volunteer, open-source, non-commercial airplane project that

was threatening Boeing. The idea sounds ludicrous. We have to acknowledge that, as a chapter in industrial history, open-source software is tremendously important.

Still, I can sympathize with what you are suggesting in your question. Simply to stamp something as open-source is not at all sufficient for qualifying it as a critical project or a project that has some kind of progressive or political sensibility. Not at all. In this day and age we need to be cautious. We need to ask ourselves: who wants the world to be open source? In fact, Google wants the world to be open-source. Facebook wants the world to be open-source. (And of course the NSA wants your data to be "open-source" too!) There are whole new production models, whole new modes of value production based on opening things. Whether it means opening up one's own life, opening up social networks, or, in the case of Google, opening up vast reservoirs of untapped data. So it's a double-edged sword. We need to do a more granular analysis of the contours of each individual case.

GH: Are you aware of this DARPA grant that O'Reilly and *Make* received in 2012, and what do you take out of the rapid professionalization of the DIY electronic field? Is it inevitable that DIY or hobbyist types of culture align with larger institutions, or do you see this as going against some of what *Make* had started . . . or is it actually following in line with what they were always doing?

AG: No surprise there. Let's remember that DARPA has been funding this since the very beginning. Have no illusions about it. At the same time, I don't want to be a hypocrite. O'Reilly's books on coding are the best in the business—everyone knows that. I first learned how to code Perl using that blue camel book, and I first learned about the details of TCP/IP with the help of O'Reilly books. I think people appreciate how they don't try to pander or patronize the reader. Yet the DARPA funding issue and professionalization is no surprise. The deeper question is, what are

the politics of hacking? Or, what are the politics of coders? That's a much more difficult question and there aren't any easy answers to that.

I get a lot of flack when I say this, but I honestly think that hackers tend to be either agnostic or neutral about politics. They are simply uninterested in politics a lot of the time. "We just want code that runs"—that kind of ethos. Anonymous gets a lot of press, but most coders and hackers do what they do because they are into code, not politics. They want to make cool stuff. Thus they tend to be scattered across the political spectrum. In fact, when they're on the left, they tend to be centrist liberals, or sometimes left-libertarians. Only a minority of hackers are what we might call left-progressives in the traditional sense. Authors like Fred Turner have tracked the history of cybernetics and shown how the rise of new media is essentially coterminous with the rise of the new technocratic, neo-liberal, global systems of government. So a DARPA-O'Reilly is not very surprising if you look at some of the deeper trends.

GH: Sure. What role do you see hackerspaces or makerspaces having within a university? Have you been involved in any spaces like this, or how do you see this kind of thing being put into universities?

AG: A tricky issue. Let's not forget that, after the church, the university is the most conservative institution in society. And I'm not sure that's a bad thing! [Laughter] I think there is a reason why universities are traditional and conservative. Certainly I support institutional critique and the deconstruction of the university system and its staid organization, for example with the culture wars in the 80s and 90s and the quest to diversify the canon. But I'm also a person who teaches classes and says "No devices in class. No laptops; no devices."

The problem is that these forms of "hacking the university" sometimes produce, perhaps unwittingly, a new makeover of the university along neo-liberal lines. Ideas like "Let's turn seminars into laboratories for entrepreneurship"—I don't think that's a good idea. I'm not against entrepreneurship, but I don't think that, outside of business school, this is what universities are for, particularly the liberal arts and humanities parts of the university. I'm quite traditional on that point. Having said that, I'm also a staunch advocate of digital literacy. As Kittler said, to be a person in the modern world, one should know at least one foreign language and one computer language. So let's learn how to code, but let's also read Plato. Ultimately these two domains can be contemplated together—think of Plato's special relationship to mathematics, for example.

GH: Can you comment on the idea of the difference between critical work that you do and critical theory as defined by the Frankfurt School? What I'm getting at here is more of an idea of the term "critical making"—whether that's a valuable term, or perhaps too academic, negative, or maybe should be updated into something else. What are your thoughts about the term "critical making" and do you think it is a useful label to embrace?

AG: I think "critical" is a good term. Like a lot of labels, it can be vacuous sometimes and, certainly, it can turn into a certain brand. I use the word critical to describe the kinds of projects I aspire to—whether that be the critical study of software, or an interest in tactical media, or the politics of code.

Consider the origins of critique. Two sources stand out. There's the one that comes from Kant and the one that comes from Marx. If you read Kant, the idea of critique has to do with the rejection of dogma. Kant had an anti-dogmatic interest in self-knowledge, the self-reflective quality of knowledge, the ability to validate knowledge without appeal to external scaffolding (in, for example,

an appeal to dogma). Kant's legacy has coloured our entire modern experience.

At the same time, there exists a similar but slightly different sense of critique that comes from Marx. This also concerns the anti-dogmatic, self-reflective, modern position. His is a rather mundane, terrestrial, and non-transcendental position. But of course Marx was driven also by polemic or antagonism. Hence the dialectical relation in which something is always in contradistinction with something else.

Marx's sense of critique is about taking a position. Consider something like Wikipedia. Wikipedia would be an instance of the opposite vector. There's not one sentence of critique on Wikipedia. This is because of the principle of neutrality that guides all writing on the site. They have very specific editorial guidelines that prohibit what we know as critique, and for good reason. Critique means you have to take a position, and you have to defend it. Likewise, you have to be against something. This produces a dynamic or differential. To return to your question, I am definitely interested in the legacy of the Frankfurt school and critical theory. I don't see a dramatic shift in that kind of methodology or approach. Part of what I am trying to do is take the legacy of critical theory (while adding bits from larger questions in continental philosophy) and reconnect it to contemporary questions, particularly ones having to do with digital media.

GH: What useful things can be taken from the concept of critical design as established by Anthony Dunne and Fiona Raby?

AG: Critical design is a bit silly. Designers have always been great at branding, and this is no exception. Design is a fundamentally critical process from the get-go. That's what the design process means. Design is an iterative process in which one revisits ideas, refashions them, recalibrates them, and produces multiple versions. That's why

people say "everyone is a designer" today. We live in the age when everyone is a curator, everyone is a DJ, and everyone is a designer. We need to take seriously the notion that, whereas a generation ago critique was more or less outside mainstream life, today critique is absolutely coterminous with the mainstream. Hence a designer might engage with a so-called critical design project on Monday, but on Tuesday produce client work for IKEA. It's normal.

GH: Do you have the same response to speculative design?

AG: I'm interested in communism. And love. And darkness. I'm interested in smashing the state. And the total elimination of petroleum. I'm interested in the end of racism. I'm interested in the next 44 presidents being women—fair is fair! Speculation is mostly harmless, I suppose. But speculative thinking has been affiliated with idealist philosophy and bourgeois thought for so long—think of Marx's aversion to Hegel—that it's difficult for me to see much hope there. I've said it many times before: we don't have a speculation deficit; we have a motivation deficit. We should keep imagining new worlds, yes absolutely! But it's supplemental. Any child can tell you how to make the world just and fair and joyful. This is not to denigrate the creative work of Dunne and Raby, who are very talented at what they do. But rather to direct the focus where it should aim. The problem is not in our imagination. The problem is in our activity.

GH: For maker or DIY culture, what are some interesting projects, groups, directions, themes or trends that you've seen lately. Is there anything you've recently seen that has been unexpectedly provocative or interesting?

AG: Well, I've tried to keep up, but I'll admit I'm not a hardware guy. I'm not a physical computing guy, so I haven't been able to participate in some of the really interesting spurs that have come

up recently like 3D printing and microchip coding and Arduino and things like that.

In terms of interesting projects, the holy grail is still ad hoc networking. Once we have truly viable ad hoc networking, rolled out to a significant number of machines and mobile devices, at that point, we will see a major shift in technology and modes of sociability. It's starting to happen with apps like FireChat. But it's still not completely mainstream, unfortunately. Imagine if the Occupy Movement was not a quote-unquote "Twitter revolution"—which is such a ridiculous and problematic notion to begin with!—rather, imagine if it was completely ad hoc, imagine if the network itself was local and ad hoc. Things would be very different. (It would send the NSA into a tizzy, for one thing, and completely force state surveillance to reorganize itself around compromising hardware and OS software, some of which they've already accomplished, instead of simply hoovering the Internet backbone—but that's another conversation entirely.) I suspect ad hoc networking will have the kind of transformative impact that something like Bittorrent had in the past.

That doesn't answer your question directly, but I think that it may be a part of DIY. I think it is, particularly since it embodies the spirit of a bottom-up, grassroots movement. We don't need a backbone. We don't need an information backbone. With an ad hoc network, just by turning on a device, we fortify the backbone, the grassroots network.

GH: Yes, and I'm glad you brought up the Occupy Movement because it's something that has been a contrast to the apolitical and family friendly tone of *Make* magazine. Many interesting things have happened in what could be termed as DIY culture through the Occupy Movement, Idle No More, or other movements that are screaming politics, controversy, and justice. It seems a bit

odd—or perhaps a bit "affluent white suburban dad"—to think of DIY culture as being apolitical.

I see the maker movement as taking the controversy and politics out of hacking. It's not quite Disney-fying it, but making experimental electronics or hacking practices family friendly has been, in some ways, key to its adoption and spreading a decade ago, and may be essential to being taken up in a popular way. But in the process it loses a lot of that punk aesthetic, hacker attitude, and rawness that is so rich and interesting.

AG: I think you're onto something. One could do a whole historical sociology of aesthetic and political techniques, let's say from the 1960s to the present, and show how they constituted genuine counterculture, even antisocial behavior, critical of the mainstream and so on. Then, at the same time, one could trace these same techniques and show how (or if) what was once more radical or countercultural has become normalized. Or even how certain techniques may have been co-opted, in essence playing for the other side.

GH: Sure, I think a good source on that process is Rachel Maines's work. Maines talks about this flow as the hedonization of technologies and of practices that once were labour-oriented and the process of how they transform into a pleasure-oriented leisure activity.

AG: Think about the status of desire. In the 1970s Deleuze and Guattari talked about desire as a radically liberating capacity—the Situationist International, too. But think about how Facebook works today. Activity, affectivity, performativity, and other modalities of desire are completely embedded in the contemporary mode of production. This is one reason why I've always kept my distance from Affect Theory. Not that I don't respect the kinds of thinkers affiliated with that theoretical emphasis. The problem is

that capitalism has already wised up. Sure, it was a radical position for someone like Judith Butler to take in the early 1990s. But now it's completely sewn into Facebook's business model. Facebook is Butlerian in this sense! So a lot of things have changed in the last twenty, thirty years or more. Critical theory needs to readjust accordingly.

Take interactivity for example. If you talked about interactive media in, let's say, the late 1960s, you were a radical by definition. Interactivity meant that media should be bi-directional, it signified an alternative to the broadcast model, the notion that should be bi-directional. So simply talking about interactivity meant a kind of radical democratic stance. But that was a generation ago. A generation and a half, even. Today, interactivity is, at best, completely normal and, at worst, slightly reactionary. I'm not sure I want Google to be "interacting" with me when I don't want them to be interacting with me. I'm not sure I want Gmail to be interacting with the emails I write, to say nothing of my "interactions" with the NSA.

In fact one could say the same thing about remix culture. I was looking recently at some early experimental film and video projects. And they are so surprisingly similar to watching an MTV bumper from the 1980s. It's exactly the same technique, hyper-quick edits, and so on. Such are the strange twists and turns of history. At one moment something is marginal, critical, even antisocial, and then a generation later it becomes normal or mainstream.

GH: So what are your thoughts about contemporary use of the term "DIY," whether through Mark Frauenfelder, Matthew Crawford, or other people? Do you have any thoughts on how that term has changed, or where it's at now? Because when you say "DIY," it can mean everything from going to Home Depot to buy lumber to programming an Arduino or a whole range of things.

Where do you think is the most useful way to take that term, where to go with it or what to do with it?

AG: Here in New York rooftop gardens are all the rage. We have so many rooftops and they're all empty. My parents were back-to-the-landers in the 1970s, and I grew up on a farm in Oregon. So I'm a product of the DIY ethos to a certain extent. I'd love to have a chicken coop again in my backyard if I could.

As I said before, we're an incredibly rich country but at the same time we're extremely impoverished. Even in our making, we've lost the essence of making. It could be physical knowledge, or it could be spiritual knowledge. You mentioned Crawford, and we could discuss others, like Richard Sennett's book on the craftsman, and so on. In continental philosophy right now people are talking about carpentry—I kid you not. Tools are very fashionable right now. We mentioned Etsy. Even in music you see a return to the DIY, hand-made ethos. Ten, twenty years ago, it used to be the height of cool to be on a small label like Sub Pop. Today it's even cooler to self-release.

GH: Right, or on cassette or vinyl, too . . . to self-release on vinyl.

AG: Right, I find that kind of humorous. We're seeing it in all aspects of culture, and of course it's still generally a good thing, whether it's in music or with Linux or Occupy. These are good developments. But we should also frame them within a larger landscape. Romanticism never gets old; there's a basic phenomenology that people never lose interest in. What I mean is that people seem to crave a sense of authenticity, a sense of sincere presence in the world. When our social relations fray and become alienated and commodified, we often see people return to what they view as a more authentic, sincere existence. It began with Socrates and it's happened periodically ever since. Phenomenology and romanticism are maybe only the most recent emblems. I think

this is a way of framing what you're getting at with the return to the handmade, maintaining a personal relationship to one's objects and, as those objects disseminate, a personal more sincere social relationship to one's friends and relations. I'm a woodworker; I make furniture in my spare time, so I get why people feel this way.

GH: I see part of it as people, in a simple way, just being tired of buying stuff at Walmart and being sort of sick of that. They're returning to using—for example—some hand-carved spoon that their grandparent made, or a quilt. And I think that it's very difficult to replicate that genuine sort of handmade, or sentimental type of object that you'd have in handmade culture.

AG: You mean, if it's computer-based?

GH: Well, that's a good question as to whether that could be computer based. I think you see some replication of sentimentality in software through things like Instagram, which adds sentimentality through software. Physical objects do have a weight to them that is maybe more difficult to replace through software.

AG: Media always play that role. We often think of media in negative terms: "Oh, these are the aspects of modern life that are impersonal." But look at what media do and how they work. I am thinking of something like the invention of anti-aliasing. The invention of anti-aliasing was precisely to add a soft, authentic, smooth visuality to images. Or you could even look in the reverse, because the flip side to romanticism is a naïve sentimentality or nostalgia. That's a trap; romanticism is an ideology in itself, of course, we should acknowledge that. But I love observing these small nostalgias that reappear here and there. People are nostalgic now for the CD as a music format because MP3s tend to be compressed and CDs have a richer, deeper, sonic spectrum. People are nostalgic for—as you mentioned—vinyl, or the pops and hisses that you hear when you drop the needle on a record. Such media

artifacts return because they furnish a more immediate authentic experience. Or at least they seem to.

GH: Right. So if you had to spit out some sources for a reading list related to either DIY culture or making or maybe critical making or handmade craft, what would it be? You mentioned Sennett and Crawford and some other sources. What would you add to that list?

AG: Related to the idea of phenomenology, a favorite of mine is the architect Christopher Alexander. In terms of the immediacy of production and design, Alexander is a legendary figure. But thinking more contemporarily, a real hero of mine is Geert Lovink—and I'm sure he's a big influence on you too. Especially that early book of his called *Media Archive*, which he co-wrote under the pseudonym Adilkno. He's been writing on this stuff for a very long time and has been thinking about critical media practice more deeply and with greater subtlety than anyone I can think of. What's so great about his work is that he doesn't fall into the two typical camps. Either people are geeks who are into hacking, and their response is generally thumbs up; or people are knee-deep in the proprietary commercial world and give it a thumbs down (when it threatens their profit margin). But someone like Lovink—or others, like Matthew Fuller, or Tiziana Terranova, or certainly the Critical Art Ensemble—is a huge influence to a lot of us these days. That kind of work remains absolutely crucial for me.

Another book that gets better and better every time I read it is McKenzie Wark's book *A Hacker Manifesto*, a text influenced greatly by Guy Debord and Deleuze. I think it's one of the few good books on digital media and digital culture. It's one of a handful of books that still stands up, now that the web boom of the late 1990s has come and gone.

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