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Tools for Multispecies Futures

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What tools do we need to move towards a more equitable, sustainable future for all people, species, and ecosystems? What stories do we need to tell and hear? Donna Haraway is a Distinguished Professor Emerita in the History of Consciousness Department and Feminist Studies Department at the University of California, Santa Cruz, and is a leading theorist in Science and Technology Studies. From her influential essay, "A Cyborg Manifesto," to her most recent book, *Staying with the Trouble*, she is a leading voice in discussions from posthumanism to multispecies justice. Drew Endy is a professor of Bioengineering at Stanford University and president of the BioBricks Foundation. Endy was one of the pioneers of synthetic biology, and co-founded the International Genetically Engineered Machine competition (iGEM), which has been instrumental to the growth of the field. Outside of the lab, his work promotes open-source biotechnology and using synthetic biology to enable humans to live more harmoniously with our environment.

At Haraway's kitchen table, over a plate of heritage tomatoes and locally-made cheese and bread, Haraway and Endy explore how tools of care, storytelling, play, and activism might guide us towards a generative, less destructive biological future. This serves as the concluding conversation for *Other Biological Futures*.

Donna Haraway: Both of us, as I experience our work, are profoundly committed to the living and dying world, to the Earth itself. Anything we do as craftspeople — as writers, as engineers, as workers with each other — has to be about thickening relationality for and with the Earth. This way our work can forestall the consumerism, the extractivism, the extinctionism, and the practices of destruction that we experience so profoundly in the world as excessively privileged professionals who are in no doubt about the degree to which our lives are part of what's now being referred to as the Anthropocene.

We know this acutely, and we try to live and practice in such a way as to deactivate the militarism and the extractivism and be part of a care-taking of each other in response to a world that values only growth in its capitalist and related modes. The only possible answer to that is *not* further accumulation and securitization and enclosure of commons and so on, but rather figuring out what it actually means to take care of each other. What would that mean for bioengineering on the one hand, and science and technology studies on the other? And what does it mean to be a serious thinker, where the job is figuring out how to take care of each other with the skills at hand?

Drew Endy: I've brought along a vanilla bean to add to the other biological things we have on the table here. This bean, as an artifact, is interesting to me because it represents this intersection of nature and enterprise and colonialism and plantation and trade, and one of the molecules in this bean has become a totem of dysfunctional discourse in the space of biotechnology.

Some people are opposed to bio-synthesizing a few of the molecules found in this bean by engineering brewers' yeast, while other people think "What's the big deal? I'll just run this in a fermentor and I'll get the same chemicals." I never understood the two voices in opposition. This is a riff on your talking about the care of each other: Previously, I only saw the landscape as defined by the molecule, or the molecule and the money, and not as a richer, entangled landscape with multidimensional meaning to it.

Then, at a conference in Toronto, I met a vanilla bean farmer from Mexico. The farmers' relationship with biology has everything to do with biology in nature, and biology in terms of adaptive agriculture and a bit of breeding, and nothing to do with synthetic biology. The farmers cultivate the flowers embedded within a forest, in a close relationship with their land. The vanilla flower blooms for a week or two a year. It has to be pollinated manually, begging the question —

Donna: — about its evolutionary history. Who were its pollinators, if not human beings?

Drew: The bean forms over the course of about nine months, and there's a whole set of cultural stories around this process, having to do with man and woman and gestation. Later, when ripened, the beans are harvested, held in common within the town, and dried collectively, so the farmers have an additional set of relationships with their neighbors. This practice of making a molecule is really about a relationship with the land and taking care of it. It's about a relationship with their stories and taking care of their culture.

Donna: Taking care of their stories, too.

Drew: And taking care of each other. So, I'm sitting in Toronto, listening to a Mexican vanilla farmer, and I'm dumbfounded. Note that everything I'm learning has nothing to do with the current political conversation about whether brewing vanilla is good or bad. There's only dysfunction and opposition in that conversation.

The fellow says, "Synthetic chemistry came along, and with petroleum feedstocks, you can make some of the molecules synthetically, more cheaply, and so it changed one dimension of making vanilla: the money dimension." That change put them under economic stress, so the farmers adapted by, for example, cutting down forests and trying a better cash crop, or trellising the vanilla and attempting to intensify its production, or something else.

Donna: Did they also adapt by trying to develop their markets differently?

Drew: That came later, after they had to experience the loss of their relationship with the land, the loss of their relationship with their stories… The key is the realization that vanilla farmers value taking care of the land, their stories, and each other more than they value money. So, they put two and two together and go, "We're going to attempt to do, for example, what they did in Champagne. We're

going to define a terroir where we can get more value by sharing our story of vanilla." Did you know vanilla arose naturally in Mesoamerica? I had no idea.

Donna: I know nothing about the bio-evolutionary or bio-social evolutionary history of vanilla.

Drew: I'm left thinking, "Well maybe I'll spend five bucks more if I find Mexican vanilla." Probably even more.

Donna: And then Mexican vanilla farmers might be able to survive. When did vanilla arise in Mesoamerica? And did it arise in company with people from the get-go? I want to search for the evolutionary history of vanilla because now I'm fascinated by the multispecies issues: what are the mycorrhizal associations with the vanilla plants, and who are the pollinators? Have the pollinators become extinct, or did people become essential?

This story excites in me this desire to know. It's not about commodities, it's about a sense of being alive on this Earth, the incredible pleasure of connecting with these rich ways of *doing* the world. Not to take them over and extract them, but to get a sense of the richness of connection. That nurtures my sense of being committed to taking care of each other so that once you tell me about the Mexican vanilla farmers, there's some way in which they can draw on us for support.

Being introduced to this story produces a kind of ethical accountability that is about taking care of, not in some paternalistic or condescending or colonial way, but rather: If I'm eating their vanilla, I owe them more than money.

Drew: They owe me more than molecules.

Donna: There is reciprocity established here that cannot be contained by the market and by capitalist imperatives to the growth of consumerism and markets. There's something here that inspires the possibility of resistance to the ongoing extractivism, even while we know perfectly well as you handed me this bottle with a vanilla bean, that this is a colonial product. This is a product in imperialist trade networks, but it's not reducible to that.

How do we inherit both these networks of unequal trade that also ramify into synthetic chemistry, in petroleum stocks, in the synthetic vanilla that displaces the vanilla farmers? What kind of growing of the reciprocity of care do people like you and I participate in as a resistance to the ongoing extractivism?

Drew: Yes, and I'll take that a step further: It's one thing to be in resistance, but it's another thing to transcend resistance with opportunity.

Donna: Exactly. Resistance is not enough.

Drew: There's another part for me, about my experience of the vanilla farmer, which I hadn't anticipated. He was sharing what happened in response to synthetic chemistry, to this one-dimensional commodification of a molecule, and he had nothing to say about synthetic biology, other than he had experienced that civil society organizations were expressing concern about it for reasons that he could appreciate, but he didn't know the details. To hear him say this was liberating: It freed me from the contemporary dysfunction of, "Is it okay to brew the same molecule?" in a yeast fermentor, which is not a very interesting conversation, as it turns out. Liberated from that narrow focus, the opportunity became instead about "What could I do?"

Donna: Does my skill set have anything to offer here? Or is it in the way?

Drew: It's definitely getting in the way — through all the reasons you mentioned before, but, if you return to the value of relationship with the forest, to one another, then what a would-be engineer of biology might offer is different morphologies of flowers, supporting different stories, different visceral experiences during the harvest so that community is reinforced or strengthened. Things that have nothing to do with what might end up on a grocery store shelf, but everything to do with the experience of the person connected to the making of the thing.

Donna: How do you imagine the synthetic biologist can contribute to that?

Drew: I have to admit that prior to my interaction with the vanilla farmer, none of what I'm saying is even in anybody's imagination. It's only through the connectedness that these things arrive as an opportunity, and then the opportunities that emerge are quite numerous and create a type of vacuum that can be filled constructively.

Donna: I have a general line about the nature of being an earthling: that earthlings arise through opportunistic innovation. If you think about it semiotically, the biological world is about recognition and misrecognition. From the get-go, the smallest possible thing you can think about is relationship and relationality. You have relationality all the way down, and emerging out of tropisms, positive and negative, and recognition and misrecognition. Comings-together that then add on to each other and complexify each other, and then fall apart.

Every composing and decomposing produces something in the world that wasn't there before, that may just disappear, but may become the opportunity for some other kind of composing and decomposing. Tropisms are fundamental at the level of chemistry, or at the level of particle physics: the kinds of attraction and repulsion that make up what is. At every level you might choose to think about it, these attractions and repulsions are fundamental to entities and what they do with each other.

Drew: What you're describing is that there's no pattern.

Donna: Patterns emerge from precisely these processes, because these processes, among other things, produce environments in which some patterns can survive and others can't. Every kind of coming together, such as you and the vanilla farmer, produces an emergent possibility or opportunity, out of which other kinds of life may or may not be cobbled together. But the possibility for something to exist on this planet that really wasn't there before emerges out of encountering. This is a general property of being an earthling.

If you come down from that general property to the encounter of the synthetic biologist and vanilla farmer in Toronto who undid and redid each other, then there's a narrative about what happened that doesn't pre-exist the encountering.

Drew: This is play.

Donna: Exactly right. This is what play is. The synthetic biologist then one day met the feminist science studies scholar through the synthetic biologist telling this story and giving a gift. The first thing the feminist science studies person and the synthetic biologist did is take the vanilla bean out of the vial and start touching and smelling and eating and passing around, and pretty soon they were so sensually involved in the vanilla bean that they had to figure out how this was going to help them take care. That taking care of their connections in the world, in a certain sense, farming the connectivity that they're always already a part of, is what they think of as being a responsible adult.

They think of it as the only way they can possibly address the ongoing extractivism of capitalism and commodity consumerism and militarism, the world they are part of, is through figuring out how their skill sets can enhance caring for each other as earthlings and open up opportunities that are not about yet more capitalist growth, which is killing us dead.

Drew: This taking care of things is very interesting for me. There's the phrase, "The grass is always greener."

Donna: By the way, as you say this, take this dried tomato which comes from our yard.

Drew: Oh gosh.

Donna: They live on this soft cheese and these little garlic croutons. We'll talk about heritage tomatoes in a minute. You were in mid-sentence…

Drew: The grass is always greener has this type of extractive "exploit and move on" sense to it.

Donna: "We've ruined this patch of grass, let's go over there."

Drew: But in a biochemical sense, there's a reverse complement to that phrase, which is, "There are dead spots all over the place, everywhere." Everywhere there are problems. The lesson I extract from that is, things are good where we take care of them.

My reaction is to return to this taking care of things and to recognize some of the asymmetries that are structural within current ways of existence and working. How many people do you hear going around saying, "Ah, there are dead spots on the yard everywhere"? People are always saying the other half of the cliché: the grass is always greener. By not having symmetry in that simple story, we miss the point.

Donna: My friend Anna Tsing, an anthropologist, has this phrase, "The arts of living on a damaged planet," which has been very important to me.

Look at the Point Reyes grasslands in California, which have been in deep trouble in a number of ways for quite a while. Because of the burning regimes, the forest and grassland relationships are screwed up, after many years of being essentially a mining operation for agribusiness.

What does taking care of the grasslands of California mean now? It's from that world of taking care of the land, by the descendants of the settlers who dispossessed the land in the first place. Ranchers in Point Reyes are now raising cattle in a sustainable way, which is restoring biodiversity to the grasslands.

The indigenous people of this area, some of whom are in active collaboration with the farmers, ranchers, and tourist industries, are working to rebuild tribal sovereignty and youth rights in relation to the land. The questions that interest me here are about taking care of our relatives, taking care of our kin. Being a part of care-taking relationships that involve grasses, cattle, sheep, white settlers, contemporary Coast Miwok, and other descendants of the land, tourists, wildlife biologists, wilderness advocates. All of the above have stakes in the grasslands of Point Reyes, and they have different imaginations of what this land was and what it should be.

How do we, as adults, drop the mask of innocence and engage in multispecies civic politics? Those questions interest me. It's what I mean by "staying with the trouble".

Drew: I'm with you. Can you help me understand? I'm a student of moves that were made centuries ago, that I inherit only because they shape the system that I'm operating within. The separation, for example, of the human from the rest of the world, which happened four centuries ago, in part, feels like a good hack to me because it takes a whole bunch of things and gets them to be the domain of science, to a degree. But by separating the human from nature, four centuries later, we've accumulated some debts. I'm trying to figure out how does one reconnect to nature as a human, without triggering the gardenification gene? Where it's like "Oh, we're going to take care of everything and make it exactly how we want. We're going to make it completely nice."

Donna: There's some kind of fantastic preset.

Drew: Because on the one hand, there are certainly people believing that they can do that. On the other hand, I think most of us have the experience of being buffeted by the vagaries of nature in ways that are not under our control, and so somehow those two things feel in misalignment, and the bigger faction either appropriately doesn't believe or trust the smaller faction that seeks to make everything work.

There's a way of interpreting what you're saying, in other words, which is, "Yeah, we're going to figure out what to do on Point Reyes and we're going to take care of it. It'll be a beautiful garden and everything will be idyllic." I don't think that's what you mean. Is it?

Donna: No. I would oppose that faction.

If we were at a meeting together around what's going on at Point Reyes, I would find myself arguing vociferously against that "beautiful garden" image. But I'm a biologist by formation, and I have profound loyalties to the science that shaped me. Biology is at least two different things: it's the historical discourse of biological knowledge making, and it's the biological world, which isn't the same thing.

I feel the history of engagement in the world by biologists has made the world a richer place in all kinds of ways, certainly at the level of knowledge. I feel in debt to the people who made and continue to make this possible, and I am simultaneously aware of the degree to which this knowledge-making apparatus, which tells a story about itself, is separating nature from culture, studying nature separately from human politics and religion and the rest. I know there's a grain of truth in that story, but there's also a huge amount of self-deception because the history of biology is the history of human beings engaging the world with technologies and the projects of knowing.

I just wrote a paper with Michael Hadfield, called the "The Tree Snail Manifesto". He's a marine developmental biologist, and he's dedicated at least 40 years to working fiercely, ferociously for the Pacific Island tree snails that are highly endangered, with many groups extinct. He's found himself needing to change from a so-called pure scientist. Now he thinks and practices his biology as deeply engaged in putting his body in the way of yet another military free-fire zone, into their habitat, and educating Pacific Island kids, nurturing them through PhDs, listening to their knowledges and helping them as policymakers and biologists and teachers when they go back to Guam or the Northern Mariana Islands. Michael's biology has become this mature, multi-sided practice, all of which is biology. He had to drop the idea that the biology was somehow separate from the culture.

Drew: It's connected biology.

Donna: It was connected, and he understands that seeing the Pacific Island tree snails as if they were separate from people involved extinctionist collection practices, abstracting the tree snails from humans and nonhumans taking care of them. It involved devaluing the landscapes of the native Hawaiians who had different practices of land use that were vastly less destructive than the ones that threw up the colonial Pacific Island marine research stations.

The story that nature is separate from culture actively suppresses the actual practice of biology, which is involved, in a very complex way, in civilizational projects by Western explorers and by indigenous Hawaiians, and by both of them once they're in contact with each other.

Drew: Where does this come from?

Donna: This narrative of separation?

Drew: How did we become so damn special?

Donna: How did we become so dumb? Well, I think for good reasons. I think we are made dumb, by which I mean not understanding the connectedness of everything. We background connectedness in order to foreground other, very specialized kinds of things, which are themselves complex and fascinating. We do some of that for good reasons. You can't do everything all at once. But we tell stories about this that protect us from understanding the conditions of oppression and extraction and extinction that make our work possible, things we might work on in our free time, but that are supposedly not part of biology. We might be good public citizens outside the lab, but inside the lab, we leave it at the door. I think we actively suppress the knowledge that everything that goes on in the lab relies on these stories we tell ourselves.

Drew: The mechanism that's connecting us today is this journal connecting design and science. In those simple words, nature doesn't appear to show up.

Donna: Because "nature" is a really important word and I don't want to throw it away, but I worry about the oppositional quality of nature and design as if they're two different things.

Drew: I'm with you.

Donna: Faced with these kinds of impossible languages, categories do violence to the very thing you're trying to talk about, I try to talk in language that feels weird at first but really isn't. I'm really interested in talking about being an earthling more than I am about being an organism.

Drew: Well, you belong to something, or you're part of something.

Donna: Literally. You're an earthling with other earthlings, and our job is to figure out how to live and die well, with other earthlings. "Nature," for Westerners and people who have been influenced by Western histories, tends to mean "that which is separable from human activity," and you might add in a few indigenous people, but only insofar as they are more natural than you are. In short: a colonialist move. Meanwhile, the "real people", the designers, the scientists, are left as not natural. "Nature" is an impossible category for our conversation. "Design" is actually a concept we could probably stay with longer. "Nature" won't help.

Drew: Thank you. I'm with you.

Donna: There are some conversations where we really have to say, "I'm for nature and not for what you're talking about." They're very situated conversations.

Drew: Let me see if I can run some things back, because I'm suspicious that we're not agnostic with respect to certain things. So far, we've got something on a very fundamental level, about things interacting, bumping up against each other, playing. Whether it be molecules or other types of things.

Donna: That just seems fundamental to the cosmos.

Drew: Right. That, then, leads into the pleasure of connectedness among other things, allows us to install ourselves because it's already been done for us as earthlings. We don't get to do it, it's already been done.

Donna: Here we are.

Drew: You had asked me what I, the would-be synthetic biologist, would have to offer the Mexican vanilla farmer? What I have to offer initially is *play*. A possibility to have a conversation about what might be interesting. I could make up things from there, but that's as much as I can see right now.

Donna: The *play* is so forbidden really.

Drew: It's really interesting.

Donna: I get some of this from Gregory Bateson, and some from Marc Bekoff, a biologist who spent his life studying the bio-behavioral communication and ecology of canids, including domestic dogs. Some is my own too, but playing with these, the three of us playing with each other leads me to say things this way.

This is a story I get from Barbara Smuts: a dog and a donkey learnt to play with each other, even though one inherits the bio-behavioral repertoire of a canid, of a hunter, of a carnivore, of a wolf, and

the other inherits the bio-behavioral repertoire of the herbivore who is hardwired to be suspicious and wary of the kind of hard stare of the carnivore.

We've got predator/prey here. Yet these two actual beings learned to play with each other. She argued that basically, the donkey and the dog understand each other's bio-behavioral repertoire. They have to, in order to relate as predator and prey. But what happens when they relate not as predator and prey, but when the dog gives a signal that precedes a play bout to the donkey, that says, "Watch out, what's going to be done next semiotically, does not mean what it means."

In other words, it's a kind of meta-communicative signal that loosens meaning from functionality. Meaning in a whole lot of life is necessarily tied to functionality; meaning is about getting something done, and you need it. You need meaning to mean something that you can do. Function is fine, but if meaning is totally functional, you've got nothing but a very boring machine. And that is not biology!

The interesting thing about meaning is that it provokes degrees of freedom. If you do stop-action camera stuff on dogs playing with each other, every few seconds they're giving little abbreviated metacommunicative signaling that says: "Are we still playing?" They're constantly checking in with each other and saying again and again, what is about to happen doesn't mean what it means. Every play session recombines the elements in ways that never existed on Earth before. They're constantly experimenting with possibility. That's what play is.

Drew: Can you replace the functionality of what you've just said, with extractive utility?

Donna: Well, extractive utility is a kind of functionality. It's not to say that utility's a bad thing. But if that's all that it is... Play is incredibly general to being an organism, or being an earthling, but it's highly developed in some groups compared with others. The social vertebrates like dogs and humans have developed play capacities to an extraordinary level, as have many other vertebrates, but a bunch of invertebrates have too, as it turns out.

Play is a really, really big part of the lives of social critters, and what happens in play basically is propositional. Is interrogatory. Plays are these ongoing entanglements of proposition that may be taken up or dropped.

Drew: You know how molecules play?

Donna: Propositionally?

Drew: Yeah. Would you say evolution is molecular play?

Donna: Oh, absolutely. I think that the absence of play is the absence of any degrees of freedom, crudely. Anything that is fundamentally stochastic, as a huge amount of molecular interaction is, opens

up the possibility of combining and not combining. Very little on Earth is tightly determined.

Critters get good at play. They often learn to play with others from very early on. To paraphrase, Marc Bekoff says, "Look, the origin of ethics is here. It's in the recognition of collaborative play and the exclusion of those who don't know how to play, and the ethical behavior is essentially a play skill. It's taking things up so as to remain safe enough to stay in the game." The ongoingness of the game depends on its players knowing how to keep it safe enough to stay in, and the payoff of play is joy, basically.

Drew: Many forms of joy. Discovery, innovation. The new thing.

Donna: Absolutely. It's stronger than pleasure.

Drew: Implied in what you're describing is a capacity to communicate, to express an intention and to receive that expression, and there's also a capacity to be honest. I'm expressing something and I mean it.

Donna: And I'm not going to cheat. If you cheat, you will be excluded from the playgroup.

Drew: Right. When you make this connection to ethics, it reinforces your lesson.

Donna: It's not like calculation doesn't happen in biology, like gene calculus of some kind, around adaptive payoff, it's that I don't think they're what drive biology or evolution.

Drew: We've got interactions, we've got connections, we've got patterns emerging. Just thinking of evolution as molecules playing is very evocative, and also very literal for me suddenly.

Donna: I mean this very literally. I even think it's a necessary way to feel because I think serious people take care of the world we're in, and that means there are consequences.

We know a little. We need to hook up to lots of other people, including vanilla farmers in Mexico and people who are hungry for those kinds of connections. Making them more robust, I think, can be part of not just proposing worlds, but actually living in worlds that are not as vulnerable to the ongoing destruction by palm tree plantations and their ilk, to the ongoing disaster that I call the Plantationocene. The ongoing monocropping and forced labor of the Earth in all its forms, including its techno-scientific biologies.

I think the kinds of biologies that I am against are engaged in the radical simplification of the complexity of biology. The radical reduction of connectedness in order to produce extractive value and functionality.

Drew: Our synthesis can go in a couple of different ways. When one gains a capacity to *make*, that can be organized by domains outside of the capacity. It makes it sound like the making and the organization of it are disconnected. But a synthetic capacity can be organized to make everything homogeneous.

Donna: Or diverse, connected for living and dying to matter.

Drew: Right. In other words, there's optionality there.

Donna: There's a real ethical decision to be made. It's not a single or simple decision, but I do think we, on a collective level, are at a kind of branch point about where we're taking what we've inherited.

Drew: Have you encountered a narrative, either of your own creation or from others, that you find sufficient as a type of reality North Star, by which one could architect action? Because I agree with you. I don't think it's the narratives, I think it's a pragmatic suspicion that collectively, you and I and people we know, and people we can learn about and play with, are able to figure some things out. But to what end?

Donna: Not in any kind of single way. I don't expect to be satisfied in that respect, but I do want some orientation here. I think that there are urgencies in this historical moment we happen to be alive in. I think play is a terribly important part of what we need to engage in order to live and die better with each other. There are some things that have felt enduring to me, that feel orienting. One of them is a kind of serious attention to the craft of storytelling, and learning to listen to other sorts of stories, not just one's own. A cultivating of the craft of listening and telling stories.

The way you told the story of the Mexican vanilla farmers, in fact, was a very good example of that because it oriented you toward a kind of connectedness you want to be stronger and to be part of helping make stronger. The storytelling interpolated you into it in such a way that I think you could say it offered to make you a better person and the farmers stronger. There was an ethical implication to the story.

I think of storytelling as an opening up of the possibility of that kind of feeling of being with some worlds and not others. It's not like we have a general decision calculus for that. It's place-based, it's history based, it's story based, it's not the general to the particular, or the systemic to the case. That storytelling is imminent to the worlding.

Drew: Storytelling, if there's a symmetry, it's both storytelling and story-listening. I've been at many institutions that have departments of communication, by which they really mean asymmetric broadcasting. I've long wished to be in an institution that has a department of listening.

Donna: Wouldn't that be neat?

Drew: So far we've got the tool of play, which is insufficient but necessary, I'd say, and then you're bringing forward this—

Donna: —practice of listening and telling. I think that descendants of colonial settlers, people who inherit an imperial formation, tend to think they can own anybody's story. That once you hear it, it's yours. Well, that happens not to be true. There's a question of who has rights to whose stories, who has access to whose stories, and who can do what with who else's stories. It is possible to know where the good is that you can extract and make money on, or you can extract certain kinds of stories to enhance your own group in some way. Well sorry, stories are not necessarily available like that.

The question of what's public and what's not is interesting here. What are the conditions of access to each other's ways of life? Anthropologists — this is a stereotype — are said to have long collected the stories of other peoples, but under conditions of asymmetric power that they weren't adequately accountable for. I actually think anthropologists have been less bad at this than most other people, but the question of essentially stealing other people's stories — their ways of making sense in the world — have simply been taken by those who listen, but not to be responsible to the people who tell them the story, but to take the story elsewhere and do something of their own with it.

Drew: I have to admit this is connecting to a number of things that animate my struggle. The train I'm on is one in which this extractive storytelling reflects back in terms of redefinition of the word "literacy". For example, people talk about scientific literacy, which is a designed literacy. All of a sudden, literacy doesn't mean what you think it means. It means "We've told you about it." It doesn't mean you can practice it.

Donna: Exactly right.

Drew: It's an asymmetric literacy.

Donna: Scientists will tell you what it really is.

Drew: Right. Somehow, this is something that I'm in the middle of. I find myself using storytelling as a tool to get people to question what they're part of. "How many people do you think should be able to read and write?" I'll ask. I start with, "Pick your favorite human-to-human language," because people will typically go, "Well, shouldn't everybody be able to read and write?" Most people round here–

Donna: –give you a yes.

Drew: Then I say, "How many people should be able to read and write a computer program?"

Donna: Most people.

Drew: You get people wondering about that. Then I say, "Well, how many people should be able to read and write DNA?"

Donna: Then the stakes change radically because insofar as DNA is a molecule, it has to be in cells and a lot of other things, but as a molecule that basically reads and writes who's going to be an earthling, that's different from reading and writing Indonesian.

Drew: Maybe.

Donna: Although, reading and writing Indonesian probably will determine who lives and who dies.

Drew: Exactly.

Donna: The differences become less radical as you start unpacking.

Drew: Tweets are dangerous.

Donna: Well, semiosis is dangerous, making meanings is dangerous. There is a kind of fetishization of biomedicine and a fetishization of techno-science, and a deep fetishization of DNA that calls it the book of life, the master molecule.

Drew: Molecular chauvinism.

Donna: Molecular chauvinism that makes reading and writing and DNA feel like reading and writing as God. There is a profound sacralization of DNA.

Drew: This is what I'm talking about. I'm caught up in the middle of this.

Donna: Do you bring God down in this case? I do have the goal of bringing down the fetishization of molecular biology every chance I get.

Drew: The story I attempt to do in a different, or just a complementary way is when people talk about how dangerous DNA could be. I say, "Well, words are pretty dangerous too," and, "We're going to regulate." Regulate is the verb people want to use. "We're going to regulate some people."

Donna: Yeah, that is the word people go to.

Drew: "We're going to regulate biology, just like we regulate Bob Dylan." In an indirect way, it's an attempt at de-deification, and it's saying most people don't think our poets are regulated, but of course, they're heavily regulated, just the regulation has been marketed as freedom.

Donna: We don't think of how the publishing industry is.

Drew: There are all the soft powers.

Donna: How poetry gets into the world.

Drew: Yes. But free speech is not what it seems. There are certain things you can't say.

Donna: Many things you can't say, and things you shouldn't say.

Drew: I'll just admit, this particular story of, "We're going to regulate biotechnology like we regulate Bob Dylan," right now, at least, does not work very well.

Donna: No. Despite that I understand and could probably speak persuasively for a commons in DNA, and that I see you as an activist for a commons.

Drew: I just came from a meeting about this.

Donna: I'm trying to figure out why not, because I think it has to do with mistrust. Mistrust of each other, mistrust of the enclosure of the commons, that you make DNA a commons and then it's re-enclosed in ways that are extremely hostile to those who thought they were building a commons. This of course happened with computer language and with UNIX, with Facebook: the making of a commons can be a stage in a yet another level of enclosure.

If the commons is maintained as a commons, that may be interesting, but I feel the forces of corporate enclosure are so extremely powerful in molecular biology and many other domains of practice, that my mistrust is at red alert levels.

Drew: Should be.

Donna: Then there's the question of "Okay, so people get to read and write DNA synthetically, but how about the nonhumans?" By the way, I would be funding you if you were making dragons.

Drew: It's easier than you think, so be careful. It might be expensive…

Donna: But it's not necessarily hard? Well, I want to hear more about that in a minute. But because I think human exceptionalism is a big problem, and I think this question of what counts as a commons usually means what counts as a human commons, and it might mean what counts as a rich person's commons. You can see how you might work against that. You probably wouldn't win, but maybe you could forestall the process of turning that into a feedstock for enclosure and value production and extraction at yet another level, that the commons then is a pre-conditional future extraction.

You might see ways to make that hard, but the human exceptionalism issue hasn't even been approached here, and a good deal of what's being changed in the world of a DNA commons is *not*

human. If it were only changing human beings, I probably would have many fewer ethical problems with it than changing other critters. Of course, we're changing other critters all the time, but it accelerates it. It makes part of it deliberate, although there are going to be vast numbers of accidental or unintentional things that happen.

Drew: Donna. I'm with you. And I'm just going to summarize the moves we've got so far. We've surfaced the move of play and the move of story. Those are the two categories of tactics we can deploy.

Donna: Powerful ones.

Drew: They are. When you see me doing something like the Free Genes project, which grew out of iGEM, this genetic engineering Olympics for high school to college kids, which now involves 6,000 people a year. These people are doing all the normal things, not all of which are good, but many improbable things that are stunning. They start with empathy and narrative, and location and connections. Over 15 years, it's gone from 16 young people, the renewable resource, to 6,000. Why is it so tiny?

Donna: Bigger than anyone imagined, and very tiny.

Drew: Right. If we're talking about wanting one percent of human civilization to be actually literate, not asymmetrically literate, to be able to read and write with all the baggage of molecular chauvinism, then what we've got now isn't going to get us there. I've been trying to figure out how does one get connected to more people? For example, I go to Guadalajara and meet with students and the makerspace community lab managers for all of Central and South America. And one thing they report is that the DNA parts collection that comes through the iGEM competition gets hung up at the border.

Donna: The DNA can't cross the border?

Drew: The teams are disadvantaged with respect to people in Europe or elsewhere, who don't have to wait six weeks to get the stuff to work with. This is creating a selective pressure to create a synchronet that's indigenous, that allows for things, so okay, fine.

Donna: A little black market in the stuff.

Drew: Well it's not a black market, it's just its own thing. You look at the instantiation of the regime that practices molecular biotechnology, and it has created structures that are just transaction costs all over the place, that practically disallow connections for most groups of people, which is important.

Let me say it differently. So, on the receiving end of the technology, if you needed a medicine that the World Health Organization might declare to be an essential medicine, the reality today is about two billion people have a supply chain that can get you that, and that means most don't.

Then if you talk about agency literacy, what type of story will you tell about something if you've never heard of it, or if you've never played with it? The answer is you're only going to tell somebody else's story. Anyway, I'm just admitting that everything you said five minutes ago around red alert, skepticism, commons is true…

Donna: And human exceptionalism.

Drew: I'm totally with you, and all I'm reflecting back is the moves I've got are play and narrative, I'm trying to figure out how to enable…

Donna: And dissemination. That's another move. A kind of sporulation. You're trying to get things out there in spite of the barriers.

Drew: It goes back to this … What was the word you were using for the things interacting, connecting, bouncing, vibrating? It underlies patterns, underlies relationships. This very fundamental move. We'll have to remember that exact word. But I'm just admitting to something. Do you understand what I'm doing?

Donna: I understand. Also, you're igniting in me something unexpected, which is wanting you to succeed at this. I would like to see these groups of youngsters, those kids in Latin America and Central America and Mexico, have access to the stuff to do these amazing things that you described among the 6,000 kids who have already had a chance to do it. Things are happening that I would not have expected to happen, and apparently, you didn't either. But they're doing things that actually enhance the sort of world we've been talking about all afternoon. I'm sure they've been doing some stupid things too, but …

Drew: Art students in Bangalore, when presented with BioBricks parts for the first time and trying to figure out what to do, decided to engineer *E. coli* to make geosmin, the odorant molecule released when wood decays. It's found when the monsoons pass and the soil is drying and releases that earthy smell.

Donna: Which is a fabulous smell.

Drew: Their motivation was that everybody around them had no idea about any of this stuff.

Donna: Geosmin, what a wonderful name.

Drew: Yes. They wanted to make something that would allow them to tell a story. Anyway, so I'm sitting there dumbfounded in the auditorium at MIT, going, "I don't know any of this. You're teaching me all of this and it's amazing." For every one of these exceptional stories, it's not an exception. There's an order of magnitude with more industrial money-making. So, access and the space are dominated by

the contemporary two-dimensional world of making molecules and making money. The complexity of this, which is both orthogonal and multidimensional as it is intrinsic and via connections, is what I'm smitten with.

Donna: Yeah, and trying to make stronger.

Drew: But I will share the same honest nervousness around the capture and all the risks, and as these capacities emerge and become practically real, the risks are real.

Donna: Nothing good is going to come of this creativity, this biological story creation, because it's going to be appropriated by forces of destruction that are already in too much control of the world, and are only going to be more so. Facebook to an order of magnitude higher. Instead, I'm going to take all of my experience to date, which makes me very authoritative, and say, "Shut it down." That is the reaction of preachy prohibition. Is it wrong?

Drew: You mean Lifebook and Microbesoft are not what you want?

Donna: You can say, "Look at what's been happening here, and look at all of us who are optimistic and trying really hard to make good things happen here, well frankly, we lost collectively, and we're going to lose again. I'm going to take all of my talent and money, and protect my students best I can, shut them into their laboratories, and I'm going to argue to shut this whole thing down." It's a possibility. Martha Crouch did that as a molecular plant biologist a few years ago in Indiana.

Or you can say, "It's going to happen anyway. I may be a talented and productive worker in this field, but I'm not the whole story. No matter what I do, this field is going to develop, these technologies are going to develop. Therefore, I'm going to take all of my skills and all of my knowledge and all of my lust for connectedness, and I'm going to do my damnedest to contribute to the kind of strengthening of those who will be telling better stories, who won't have given up, who are not going to say, 'The forces of evil are going to win anyway,' people who are still trying to make lives matter. I'm going to throw my strength behind them. That will include my skill set."

It seems to me that you have made a choice in this regard, one which I respect, which is to throw all that you've got, and you have considerable power in the world, behind what most might say is going to be the losing side. Which you're going to say, "Well, maybe not. The sky may be falling, but it hasn't fallen yet, Chicken Little." It matters, to take these capacities and skills and all the rest of it and connect with the people who are trying to make worlds otherwise.

I think I'm trying to make myself feel good about the choices I've made, I try to think that's what I've done too, but who knows? I feel like I can't become the Chicken Little person. I've got to be the person who feels stories and play still have a chance.

Drew: Prior to what you were just describing, my internal designs were to enable a flourishing civilization grounded in citizenship. Without being very clear about, citizen of what? The difference, the net impact of today thus far on me, is the earthling and this flourishing, and what it means to be an earthling.

The other thing I would have said ten minutes ago is, yes, I'm trying to secure operational mastery of living matter. I want to understand how to transcend Humpty Dumpty. I want to be able to take molecules and construct an organism —

Donna: — that actually works. And maybe even can evolve.

Drew: Right. As an engineer, what I mean by operational mastery is I don't understand it all. The structural engineer understands gravity well enough to make a suspension bridge, but the mystery of gravity is very deep. Now I'm on the hunt to replace "operational mastery" with better language. That's one thing. The second thing I want to offer is reflection.

Donna: Not operational collaboration?

Drew: Or optionality.

Donna: Or something. Something that has a more open and connective notion to it than mastery.

Drew: Operational connecting? Noted. I'm working on it.

But the second is what connected me to you originally. It's a two-part thing: the dissatisfaction of, call it the white male diagnosis of industrial capitalism, going all the way back to Marx, and this dichotomy of this way of plenty and all these other things we don't want. This two-part dissatisfaction/dichotomy flows for over a century, into the contemporary, and when you look at it as a student or a would-be protagonist trying to come off the sideline and hack to make things better, you're like, "This is a disaster." There's nothing one can operate with here. It's just a critique. You show up in that context, and as an agent, you're offering what seems like this breadcrumb trail that's operational. On the one hand, it's not getting caught up in dualities, on the other hand, engaging in a diversity of narratives that says, "There's going to be a lot going on here, and we don't have to — in fact we don't want to — make it all homogenous. In a way, we want the opposite of that, where opposite may be multidimensional."

Donna: Staying with the trouble.

Drew: It's realizing, "Oh, we're not going to make everything perfect." Part of what's going on here is keeping with this real thing in a way that allows for an operational moving ahead. In other words, by

not assuming the pressure associated with a mantel of, "We're going to make everything perfect," that allows for an escape. That's not escapism.

Donna: That makes sense to me.

Drew: But a very practical escape. This experience of your writing and trying to interpret it as a naïve innocent and reflecting it back on the dissatisfaction of critique, which is just a prison of duality and not operational, is pretty intriguing to me.

Donna: My own way of telling the story about my own formation begins in my experience of the women's movement and feminism, which is relentlessly committed to the body, to the practical, to the fleshly, to the earthly. That really cannot live in abstractions and dualities. It can't live with these ultimate teleologies, that staying with the trouble is about getting the kids off to school or getting the poetry written even though you're working in the laundry in daytime and cooking for your family at night, and you're still writing some poetry. These kinds of lives…

Drew: Oh my God, that's awesome.

Donna: … These lives that are relentlessly engaged in making living and dying work. That it actually has to work. You can't just fantasize about it, things have to come together well enough, they have to hold. But it's also just full of longings and curiosities and propositions, this kind of living. You use abstractions as tools because they help clarify things. They're very valuable tools, a lot of people lived and died to build a decent abstraction. It's a really valuable tool. You don't do baby-and-bathwater nonsense, but you're rooted in the Earth, and I feel like that means you're rooted in mortality. You're not rooted in transcendence, you're not rooted in transcending death, you're not rooted in the solution, you're rooted in making life good.

Drew: One of the best interactions I ever had was a dinner conversation; he and she were our guests. He asked one thing and she said, "Please tell him that it's impossible so that we can do something important."

Donna: That's what I think I've been learning from the movements I feel like I've been part of. Not only impossible, but really, we don't want it anyway. It's both impossible and at best, boring. What's really interesting is living and dying well with each other.

* * *

Drew: Can you tell me about these tomatoes?

Donna: Well, if we list all the species on the table in front of us, and we started with vanilla, and we've got chocolate and really good fermented cheeses, and California table grapes, and cumin and other

spices in a scone-like thing, so it's got butter in there, and we've got almonds with chilies.

The tomatoes are grown in raised beds out in the back yard. We went to a dinner with the Live Oak Grange where some of the local farmers' market farmers have been raising and selling seeds from various so-called heritage tomatoes. I planted these tomatoes that have black skin and a deep red interior, and are the size of a small golf ball, and we sliced and dried most of them.

Drew: How do you dry them without other creatures enjoying them?

Donna: Well, we have a little box that we use to force warm air over them for 72 hours. I've saved seeds from some of the summer's tomatoes, and I'll see if I can propagate again next spring. The farm that was growing these tomatoes has gone out of business, so I don't have any access to these particular tomatoes except from my own crop this year.

Drew: You're an architect of systems. I operate inside systems, sometimes I construct subsystems within systems, but you're an architect of systems.

Donna: You think?

Drew: Yeah. Because you're structuring a narrative. That's what I mean by a breadcrumb trail.

Donna: That's a deliberate practice.

Drew: Right. Just to reflect back some things, at best, I'm a squad leader.

Donna: Oh, this is not true.

Drew: Well, but there's an architecture of a culture. When we diagnose what's happening, I can give you the nerd rapture side of it, which is looking pretty good: we're going to be able to provision enough energy, stuff, and information distribution networks to support ten billion people without trashing the rest of the place.

Donna: You really think that?

Drew: Yes.

Donna: I hope you're right.

Drew: I'm happy to elaborate on that. Because here's where I get stuck. That's part one. Part two, our human systems developed in a prior time where that possibility was not true. Not even close. They developed in response to the reality of scarcity, of power relationships so adapted, and all the other baggage. We've just got the ways that humans are organized and interacting today: parts one and two.

The third thing is parts one and two are not compatible and will not spontaneously reconcile and become best friends forever, and lead to a flourishing earthling planet.

Donna: They are at odds with each other. Because what makes part one possible is against most of what's happening in part two.

Drew: Yep. You'll be like, "Hey, you remember how the Dutch used to have an empire based on wind?" Then we had another empire based on coal, and now we're in the middle of the empire, hopefully ending, based on petroleum, and there's another energy empire showing up. We're in that transition time.

Everybody is always at risk of feeling their time is uniquely privileged. We have some unique privileges right now, and there are some moves afoot. All I'm trying to get back to, though, is: I feel I can get as far as I can by diagnosing that one and two won't spontaneously reconcile and flourish together. That's why I'm here. You have a capacity to tell a story, to enable the telling of stories that gives us a path out which is not either/or. It's the connected future.

Donna: You know how when you're young, you just find yourself doing what you do and you don't quite understand what it is? As an older person, I actually understand that that is probably my only skill. That I can produce stories that open things up for other people as well as myself, out of the inheritances I've got that are supposed to be binary opposites. There's a kind of drawing the people in through a certain sort of speech patterns.

Drew: Yeah, but there's another thing happening, which is look at the competition. The competition is a disaster. Look at what it's getting us. Here's my tiny version of this. When we first started doing the iGEM student competition thing and the BioBricks thing, we got a lot of political flak from the techno establishment.

Donna: Interesting.

Drew: "Oh, this is nothing new here, this is the same old genetic engineering."

Donna: But it isn't.

Drew: Then the same people, which is where it got super confusing for me, would say, "Oh, and there's no such thing as a standard biological part. It's impossible because everything's connected to everything else." To abstract the critique, we've already done it *and* it's impossible, so it's very confusing.

Donna: Whatever it is that you're doing is really wrongheaded.

Drew: Well, it's either already been done or it's impossible, so it's a bad idea. I just found this confusing. But this confusion went away when I realized that there was year-on-year growth because we're competing with nothing. There are no other commons, there is no other collection of genetic researchers for anybody to work with, and so when your competition is nothing, incremental utility, incremental anything is —

Donna: — you are the only game in town.

Drew: In your case, it's not that you're competing with nothing, but you're competing with some things that are demonstrably problematic.

Donna: I have always found this puzzling at a personal level, but I think I understand it to some degree if I get a little distance from it. I'm regarded as highly anomalous in the way I do scholarship. As far as I'm concerned, it's just ordinary, what in the world is anomalous about it? People say, "Well, it's the passion."

Drew: Have you been accused of being a Zilla?

Donna: I've been either praised or blamed for being passionate. That if you're passionate, you somehow have left rationality behind — which I think is nonsense — or that I don't have any arguments. That if I'm proposing these storytelling propositions and these ways of imagining worlds, somehow, I'm not making an argument, and that you have to make arguments that have linear progress to be a proper scholarly thinker.

I think we should recycle back through returning to the species on the table, as well as each other as actors and persons trying to make something of our lives.

Drew: Two earthlings.

Donna: Two earthlings who have found this connection to be really playful and interesting. But if we unpack every single one of the species on this table, our worlding operations would be unbelievably rich, and if I have any kind of methodological starting point for almost everything I do, it's starting from something like a grape. By the time you've talked about a grape for 15 minutes, you are involved in so many worlds, so many openings, and then you tie the grape to the cheese or so on and so forth, that a methodological principle for me is always starting from this and here. From something that is this and here, and worlding from there. Throwing out sticky threads. And building a web.