“This Is a New Thing in the World”: Design and Discontent in the Making of a “Garage Lab”

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ABSTRACT

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This dissertation draws on twenty-four months of fieldwork at Biocurious, a "garage lab" in Silicon Valley expressly designed to democratize science, and a self-described "new thing in the world." From that starting point, this dissertation poses the following questions: a) how does a "garage lab" come to be recognized as a "garage lab," and b) what kind of scientist works to what effect inside a "garage lab."

These questions are taken up on two levels: theoretically through a critical engagement with anthropological approaches to design, an explication of the difficulties and paradoxes inherent in the relationship between expertise and democracy, and through the business of producing an audience for and presenting "new things in the world" to the public, also found in precursors such as Thomas Edison and P.T. Barnum. Empirically, these questions are taken up as a particular problem for a group of people in Silicon Valley as they go about the everyday work of making a "garage lab" and deliberating among themselves and their

consociates over its perils and possibilities.

Ethnographically, this dissertation is animated by my participation initially as a volunteer, then as a member of the "garage lab," and finally through my participation as a member of a community project at Biocurious. Theoretically, this dissertation furthers Flusser's (1999) theory of design as "a trick against nature [the given]" by pulling it tight to the traditional anthropological concern with cultural production and critically examines the claim to democratization, finding the claim to democratization at Biocurious a reordering rather than erasing the hierarchy of expertise. Finally, the dissertation considers the afterlife of "new things in the world," which fade into the background as they inevitably move from the made (cultured) to the given (natural)

Following the text are two appendixes. Appendix One addresses the folklore of the modern laboratory by examining instructional stories told at the "garage lab," the unicorn in Silicon Valley, and the signs of domestic life in the "garage lab." Appendix Two constitutes notes towards a mechanical model that can account for the life of "new things in the world," as they inevitably form for the basis for further cultural productions.

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Acknowledgments

I would first like to thank my parents and grandparents for their unfailing support of my studies. I owe them more than I can say.

I owe a debt of gratitude to the board, members, and volunteers of Biocurious for allowing me to work so freely during my fieldwork. More broadly, I would like to thank the members of the DIYbio polity, especially the members of Genspace and the FBI agents who suffered my presence and questioning.

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Introduction

What constitutes a "garage lab" and how is a “garage lab” made recognizable as a "garage lab?” This dissertation takes up these questions on two levels: through a critical engagement with anthropological approaches to design, and as a particular problem for a group of people in Silicon Valley as they go about the everyday work of producing a "garage lab" and deliberating over its perils and possibilities.

A brief history of Biocurious, the "garage lab" in question, is in order. In winter 2008, a handful of people gathered in Mountain View, California to figure out how to do biology in a garage. In summer 2011, a few dozen people met in Sunnyvale, California to figure out how to do biology inside a warehouse converted into a "garage lab." In the three years between these meetings, some members of the Mountain View group had drifted away into other ventures, but others kept meeting and recruited new people to join them. Somewhere between Mountain View and Sunnyvale, the group started to call themselves Biocurious and called, along with their consociates in other garages, what they were doing Do It Yourself Biology (henceforth DIYbio). In the summer of 2012, the people of Biocurious would host an international conference for their consociate DIYbiologists in conjunction with the Federal Bureau of Investigation (henceforth FBI). By fall 2012, over eleven hundred people had visited the Biocurious and several thousands more had experienced Biocurious via media accounts. By summer 2014, a project started at Biocurious would raise a half million dollars via crowd funding on the promise of creating a plant that glows like a household lamp.

It is a truism that some institutions are more consequential than others. In the American post-9/11 context, few institutions are as consequential as the Weapons of Mass Destruction Directorate of the Federal Bureau of Investigation. Conversely, few institutions are less consequential in American life than a small gathering of friends inside a garage. In demonstrating how a "garage lab" is made recognizable, this dissertation reckons the distance between these points.

My interest DIYbio was sparked in much the same way many of my participants' interest was sparked - through a demonstration of how easily DNA can be manipulated. In September 2010, I attended the NYC Maker Faire held at the site of the 1964 World's Fair in Queens.[1] I had designs on doing dissertation research

[1] Maker Faire is an event for self-described "makers" sponsored by Make magazine. Maker Faires are held worldwide and fall into one of two categories. They are either sponsored by a local

around 3D printing and was at Maker Faire to see the state of the art in 3D printing and, as one does, to make connections. I wandered from booth to booth, taking in the latest wearable technology and the newest 3D printers. While wondering around, I was taken in by a demonstration, in Collin's (1988) sense of the experiment as demonstration, of DNA extraction from a strawberry. Using a strawberry, some water, a dash of table salt, a Ziploc bag, a shot of rubbing alcohol, and a little dish soap, a line of kids were extracting long strands of DNA from a box of fresh strawberries. I had to try this. After extracting my strawberry's DNA, I was invited to take tour of a full biological laboratory housed in the converted city bus, called the BioBus. Inside was a laboratory where I could analyze my strawberry's DNA and, as the volunteer in the laboratory claimed, potentially create a new and improved strawberry. I was taken in by the magic of simple household chemicals exposing an unseen but powerful constituent of the strawberry. If this can be done on a bus, where else? If a strawberry, what else?

On the Biobus, a volunteer told me that a DIYbio laboratory would soon open in Brooklyn. Over that winter and spring I

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entity, such as a hackerspace, and locally focused, or feature an international focus and receive corporate sponsorship. The New York Maker Faire, along with the Silicon Valley Maker Faire, fall into the latter category.

discovered, via Google, that another DIYbio laboratory was planning to open to the public in Silicon Valley. In the meantime Genspace, the DIYbio laboratory I learned about on the bus, had opened in Brooklyn. After the spring semester ended, I enrolled in a class at Genspace titled "Biotechnology Crash Course." We extracted our own DNA and practiced designing novel bacterial plasmids. Along the way we learned basic sterile technique and laboratory safety practices, the two being as intertwined as a strawberry and its DNA. Genspace was small and closely held, and it was policed by the professional scientists who founded the lab. The class I took included architects, artists, and designers. It was, in every way, an extension of the academic or industrial laboratory. We followed the same protocols found in academic laboratories and donned white lab coats before entering the glass enclosed laboratory.

The Silicon Valley group was organizing itself using the website Meetup and had launched one of the first successful crowd funding campaigns on Kickstarter.[2] The organizers were young, like many Silicon Valley startup founders, and were looking to transform a roving Meetup into a permitted and insured laboratory

[2] Meetup.com is a social network designed to facilitate offline meetings. Kickstarter.com is an online crowdfunding portal that facilitates fundraising around a project, idea, or institution.

open to the public. Unlike Genspace, none of the laboratory founders had academic laboratory experience. Looking on from New York early that summer, Biocurious appeared poised to challenge the traditional organization of the laboratory in a way which Genspace, or even the laboratory inside the BioBus, could not. By summer 2011, I was one of the people in the Sunnyvale “garage lab.”

Ethnographically, this dissertation draws on twenty-four months of fieldwork at Biocurious’ "garage lab" in Silicon Valley, a self-described "new thing in the world," designed for those with no formal laboratory training. Positionally, this dissertation takes a technician's view, who is to the scientist as the shoemaker is to the philosopher.[3] It rejects the whiggish view of science and technology as the inevitable march of progress in favor of drawing together the contingent nature of knowledge production with the contingent position of its technicians.

The aim of this dissertation is not to explain Biocurious in accordance with an established body of theory, but rather to give

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[3] Rancière's ([1983] 2004) writing about shoemakers in the philosophical tradition emphasizes the amount of free time their profession left them to wonder and theorize their situations, much to the consternation of their social superiors. Rancière's point is that shoemakers, as much as philosophers, reflect upon their conditions, and sometimes act to change those conditions.

an account of the ensemble of people concerned with Biocurious as their designs, deliberations, provocations, and erasures come to transform the given world of academic and industrial laboratories into a world in which it is possible to "act suitably" in a "garage lab" (Frake 1964; Garfinkel 1967,1996; Boas 1887). Hence, the primary empirical aim is description and reconstruction.

The plan is below. But first, a note on naming and quoting: Biocurious and its board members, when their actions have been public and recorded in media, academic, or legal accounts, are referred to by their actual names. For private conversations, those not explicitly public, pseudonyms are used. Lab members and volunteers, who are not mentioned in media, legal, and academic accounts, are given pseudonyms. In the interest of confidentiality, some conversations and dates have been paraphrased, foreshortened, redacted, or otherwise altered.

Plan of the Dissertation

Chapter 1. The core problematic animating this dissertation is introduced by way of recounting my entre into, and attendance at, the initial volunteer orientation held at Biocurious. At volunteer orientation, prospective volunteers were instructed on how Biocurious was to be constituted. From the board's instructive presentation of Biocurious as a new kind of laboratory designed for amateur biologists, three dynamics aimed at making the "garage lab" recognizable as a "garage lab" rather than an academic laboratory are derived. First, like all laboratories, Biocurious is constituted by a set of design principles. But unlike most laboratories, Biocurious is designed for amateurs. Second, Biocurious operates through the tenants of customer service and branding, rather than through the production of scientific truths. Finally, Biocurious is designed to democratize science, rather than to further scientific elitism. These three dynamics are explicated and linked to contemporary and ongoing concerns within anthropology, and Science and Technology Studies (henceforth STS).

Chapter 2. Biocurious is geographically situated within a post-industrial Silicon Valley landscape. A brief history of Silicon Valley as invented landscape is narrated, followed by a history of international DIYbio efforts in relation to Biocurious. Next, a longer history of Biocurious as an institution in transition from a nomadic Meetup group to a fixed laboratory is explicated. The chapter closes with a pair of matched ethnographic vignettes drawn from my initial entrée and volunteer orientation, which are interspersed between a methodological note on the particular challenges of studying an institution in flux.

Chapter 3. Building on themes presented at the volunteer orientation, this chapter begins by explicating the role design played in making Biocurious understandable as a specific type of institution for a specific audience. Next, this chapter takes up the role of volunteers in the day-to-day operations of a "garage lab." The efforts, political and personal, of volunteers, members, visitors, and board members to make sense and communicate to others the nature of the emerging institution are critically examined. Everyday life in the laboratory is examined through several cases of conflict over what "acting suitably" entails within the new institution. Finally, the consequences of not acting "in the interest of Biocurious" as a volunteer are witnessed.

Chapter 4. While Chapter Three addressed the volunteer experience at Biocurious, this chapter addresses conflict between the board of directors and membership by addressing three cases of conflict between the board and members over the direction of Biocurious. The first involves a cache of professional laboratory furniture brought to Biocurious through uncertain means. The second case examines safety and its calculation as a category enabling one to make claims to power. The third case examines how the mechanisms of corporate governance was appropriated by members with entrepreneurial experience. The chapter concludes with a discussion of maintenance and contingent labor.

Chapter 5. This chapter narrates a history of the bioluminescence "community project" at Biocurious. As participation in this project marked a change in the ethnographer's positionality from volunteer to member, the chapter also takes up the structures of participation at Biocurious and discusses the participation in terms of Biocurious' claim to "democratizing science." Further, this chapter addresses the literary technologies (Schaffer and Shapin 1985) of DIYbio and the process and implications of serving as witness to experiments at Biocurious. The chapter ends by considering the experimental program at Biocurious as a feral elaboration on the history of biological experimentation.

Chapter 6. This chapter contains an ethnographic description of the 2012 FBI/DIYBio meeting. It begins with a brief history of the FBI's involvement with DIYbio, stressing the reconstruction of the FBI in the wake of the September 11th terrorist attacks. The chapter then describes the course of the two day meetings, paying close attention to the variety of activities and organizations presenting over the weekend. The chapter closes with a discussion of a) how the "new" FBI spreads DIYbio, and b) how DIYbio has organized to educate the "new" FBI.

Chapter 7. This chapter begins by recapitulating the theory and ethnography animating this dissertation. The chapter continues with a discussion of the current state of Biocurious and DIYbio. A discussion of the perils and promises of democratization follows, and the chapter closes with an argument for considering design as a form of cultural production.

Appendix 1. This appendix collects the folklore of Biocurious. Folklore is an overlooked companion of technological development. In presenting the folklore of a contemporary laboratory, an argument for the continued relevance of folklore to anthropology is set forth. Substantially, the appendix addresses the role of unicorn sightings in resolving tensions at the lab, the gendered graffiti that volunteers created during conflicts with members and administration over laboratory maintenance, and closes with a brief selection of sentimental stories related to the author during moments of failure and disagreement.

Appendix 2. Starting with the terms wild, tame, and feral, a formal model that builds upon, and extends a pair of three position models introduced by Lévi-Strauss, is presented. The first section sets the stage for a reexamination of non-linearity within anthropology building on the changing dynamic of both Biocurious and the laboratories opened by its alumni.

Chapter 1
Orienting to Biocurious

Overview

Chapter One opens with my entrance into Biocurious as volunteer. Following a description of my entrance into Biocurious, the chapter describes the initial volunteer orientation at Biocurious. At volunteer orientation, Biocurious was formally presented by the board of directors to an assembled group of prospective volunteers in the form of a) a declaration of independence from the norms of the academic laboratory, and b) set of instructions constituting and organizing the "garage lab." At orientation, volunteers were instructed in their daily duties: ensuring that members have a great experience, selling potential members on Biocurious, ensuring that media visits are chaperoned, and policing the "garage lab" to ensure no board policies or safety rules are violated.

Following the description of volunteer orientation, I explicate and analyze three dynamics governing how Biocurious would be made recognizable as "a garage lab." First, through the design of Biocurious as a new kind of laboratory with new possibilities and new perils. Second, through the process of demonstrating Biocurious to its publics. Third, in the process of democratizing science at Biocurious. These three dynamics are then related to classic and contemporary concerns in within anthropology and STS.

My Entrance into Biocurious

My initial contact with the Biocurious came in response to an email from a board member requesting for help moving equipment into the lab a month prior to the public opening. The email was an open request for volunteers, and I sent an email volunteering my labor. In return, I received an invitation from Eri Gentry, the cofounder of Biocurious, to help move equipment into Biocurious. At this point, I had been in the Bay Area less than a week and had not yet unpacked.

Figure 1.1: Introductory Email

Date: Saturday August 20 2011 6:05 PM
To: Michael Scroggins
Subject: BioCurious Volunteers
Hi Michael! Nice to meet you and welcome to the bay area! I'll add you to the google group where I'll be posted help requests and volunteers can chat with each other. We're planning a volunteer crew cleaning early next week (day tbd by doodle - you'll see the poll once you join the group). Maybe you can make that? If not we can set a time to meet up. Very best ...

This email established the firm rule at Biocurious that communications would proceed via Google groups and group action would be coordinated via digital poll (“doodle”). I joined the Google group and filled in the poll as instructed.

After getting lost in the low-slung industrial parks surrounding Biocurious, I finally arrived at the lab around 3:30pm. As I exited my car, prior to any introduction formal or otherwise, I was immediately told by a man in the parking lot to grab a can of paint thinner sitting next to my car and head inside. There were a handful of people inside, but no introductions were offered. In place of an introduction were new instructions from someone who appeared to know what to move and where.

After an hour of moving painting supplies from the parking lot into Biocurious, I helped a fellow volunteer, whom I would later recognize as Jane, move a water bath (an incubator) to a spot in the demarcated laboratory space. As we were moving the machine, Jane noticed a beaker placed precariously inside the water bath and disconcertingly lacking a label. After taking care not to upset its delicate balance while we moved the water bath, Jane asked to nobody in particular, "What kind of scientist would do such a thing?"

A few hours later, the moving ended for the day when a new crew of volunteers arrived to put the painting supplies to use and lay new carpet in the lobby. Just before leaving, I introduced myself to Eri Gentry (whom I recognized from media stories about Biocurious) and inquired about doing fieldwork at Biocurious. Without hesitation, or questions about what I was interested in and what I might want to do, I was invited to both make Biocurious my field site and to lend a hand in making Biocurious. In a land lacking introductions, this was my entree. As I left for the day through the rear entrance, a BBC camera crew was dragging its equipment into the lab.

"Volunteer Staff Orientation"

Two weeks after my initial entree into Biocurious, I attend the first Biocurious volunteer orientation. Though it lasted only four hours, I will describe the orientation in detail as it was the only time (to my knowledge) the entire board of directors a Biocurious assembled to present Biocurious to potential volunteers.

My commute was 45 minutes, but, as I would later learn, that often doubled during rush hour.[4] Volunteer orientation was set up

[4] In a bit of serendipity, my commute would turn out to be advantageous, as I was often able to give volunteers and members rides to and from the lab.

in the section of Biocurious reserved for classes and events. The incubator, which is extremely heavy, was where Jane and I had moved it. Next to the incubator, homemade lab benches and other equipment, which I could not yet recognize, have been added. In the meantime, the interior painting had been finished and new carpet had been laid down. The new carpet is accompanied by a strong scent of ammonia that gave me a headache. As I looked around the room, I count fourteen other volunteers (two of us anthropologists) and all six board members in the room.

After a few minutes of small talk, we settled in for orientation. Volunteers sat facing the board members, who were arrayed against a whiteboard-covered wall in the style of many corporate innovation rooms. We all sat on office chairs purchased from the nearby IKEA. My assumption from the layout was that volunteers would sit and take notes while board members lecture. Like a good student, I dutifully produced my notebook and pen. Demarcating the classroom where we sat from the laboratory is the bright blue strip of duct tape put down on move-in day.

The mood in the lab was light and fun. Almost giddy. It was easy to get caught up in the feeling that something important was happening. Though I did not realize it at the time, I was not the only anthropologist at Biocurious. My presence at orientation, and the presence of other social scientists who came through

Biocurious during my fieldwork, enforced the feeling that something historic was happening. I managed to wrestle my inner critic to a standstill and go with the euphoric feeling. We were doing something important. But what?

At exactly 5:00pm, the first slide was projected and orientation began. Curiously, the title slide read "Volunteer Staff Orientation" not "Volunteer Orientation." The initial presenter introduced herself as Kristina Hathaway. She told us about her background in human resources management and corporate team building. Kristina segued elegantly from her work in human resources management to the work of producing Biocurious. The two worlds, in Kristina's telling, were connected by the common problem of governance and management. She then gave us an ambiguous charge, "you will be representing Biocurious." My euphoric feeling began to wane as it became apparent that orientation would take the form of a tedious lecture.

Following the opening slides, Kristina instructed us in operations. A basic rule: No matter the number of volunteers present in the lab, one volunteer would be considered on duty and would sit at the desk in the reception area. The volunteer at the reception desk would be responsible for giving safety instructions, issuing closing announcements, and enforcing lab policies. Kristina explains that the most important enforcement policy was ensuring all visitors had signed a waiver. She explains that the waiver was for insurance purposes, in order to prove to the insurance carrier that safety was a priority at Biocurious. The next order of business was collecting the membership fee of $150 per month, which conferred laboratory access and storage space in exchange for following the laboratory rules.

When volunteers signed up members, we were to make a few things clear to them. First, because Biocurious was not a BSL-2 facility, working with human cells was not (yet!) possible in the lab and we were to give potential members clear instructions about this limitation.[5] But, next we were told that anyone can clone genes in the lab per California law. Kristina promised that more details would be forthcoming when the safety officer spoke.

[5] BSL (Biological Safety Level) denotes the level of biological risk, and hence the precautions necessary, at a given laboratory. In the United States, the Center for Disease Control (CDC) has specified four levels of danger. In the European Union, BSL levels are specified via directive. BSL-1 laboratories present no more danger than a secondary school laboratory and are normally free of regulation and oversight. In a BSL-1 laboratory, experimenters work on well-characterized, noninfectious strains of bacteria and viruses under mild safety precautions, such as wearing gloves and eye protection. In a BSL-2 lab, on the other hand, one can work on bacteria and viruses that can cause mild disease in humans. A BSL-2 laboratory, therefore, requires greater protective requirements including biosafety cabinets, greater training requirements for laboratory workers, and a method of limiting access to the laboratory. All of these cut against the idea of open access.

Minors would be allowed to participate in lab work at the discretion of the event organizer when accompanied by an adult parent. Unaccompanied minors were not allowed in the lab. Kristina gave us a rule of thumb to guide us in moments of uncertainty: "Stupid is OK, illegal is not." After the rule of thumb, Kristina sat down and another board member rose to present.

Raymond McCauley, the second board member to present, told us the next segment would be about the customer experience at Biocurious. True to his word, the title slide read, "Disneyland as Experience." Raymond then posed two hypothetical questions, "What are we doing?" and "What are we going to let people do?" Next, he projected a slide of the Bavarian Castle at the entrance to Disneyland, then paused. The silence lasted ten seconds and ended with an injunction, "Know that you are here for a purpose." Raymond paused again. Then he continued, "You guys are here because you are the elite, like the Rangers or Olympians." In the following breath, Raymond compared Biocurious to the Library of Alexandria, then to Edison's machine shop, and eventually to the original HP garage. After a third long pause, Raymond answered the question he posed earlier, "We are here to alter the world."

The rule of thumb reappeared with an elaboration. If a member wanted to do something stupid, so long as it was safe, we were to let them do it. Raymond explained that the rule of thumb was in service to the overarching design principle for the space. Above all, the duty of the volunteer was ensuring the quality of the member experience. Members, Raymond exhorted us, should never be made to feel stupid. Members were to be built up and made to feel competent in the lab. We could only accomplish this goal, Raymond encouraged, by getting the operational details right, by continually improving our processes, and by creating a strong brand identity around Biocurious. Raymond next told us a story about the backstage chaos at Disneyland. He contrasted the story to the frontstage presentation that Disneyland visitors experience. Biocurious, he tells us, will be like Disneyland. As volunteers, our number one job would be presenting a quality frontstage experience for members, despite the backstage chaos we would experience.

Moving along, Raymond developed a corollary to his customer experience argument by warning us against displaying scientific elitism, which might intimidate members or encourage them not to pursue an idea. He did this with a brief story comparing the elitism of professional science with the egalitarianism of Disneyland:

> There is also a sense of elitism where most people who know about science were not willing to accept my naive questions or spend some time talking with me or

> educating me. We want people to come in here and have a quality experience. I mean the happiest place on earth ... I really appreciate the way the Disney corporation does things. The park is clean, the people are friendly. We want to promote a consistent experience for everybody ... So, really, truly we would let people go as far as they can legally and safely go.

Next, Raymond further elaborated the "stupid is OK" rule of thumb. These would be our guiding principles: Do not exercise editorial control over projects; Do follow safety guidelines and legal restrictions. To reinforce his point, Raymond projected a slide of the actor Jack Black's character in the movie *High Fidelity*. Pausing for effect a fourth time, Raymond warned us again against displays of knowledge that might make potential members feel less than competent in the laboratory. Biocurious was not an indie record store, and volunteers were not to exercise their opinions about a member’s taste in science. In the dramatic pause which followed, I ponder the lesson of this lecture. Volunteers are never to speak on scientific matters unless directly asked. Knowing little of biological laboratory technique, I doubt I will run afoul of this injunction.

Eri Gentry broke the silence when she rose to reinforce Raymond and Kristina's elucidation of the responsibilities of volunteers. She told us that her background was in economics but her interests are scientific. Then she gave a rationale for

Biocurious: "We need a lab for the community." In keeping with the theme of the last presentation, Eri talked about how she also had been put off by the elitism of professional scientists. She offered a slightly altered version of the charge laid upon us by Raymond, "people don't know and don't have access [to science]."

Eri framed the responsibility of volunteers as ensuring that members have access to tools and knowledge as necessary. Yet, at the same time, she reinforced that "the first rule of staff responsibility is to ensure customer service" and reminded us that people cannot hang out for free at Biocurious. But, as long as they are current on membership dues, stupid is OK.

Daily Duties and Policing the Space

Following Eri's restatement of the "Stupid is OK" principle, the next slide made a sharp turn in tone and substance. Eri returned to the daily duties of the volunteer. She told us about staffing schedules, Google groups, and various email addresses that would coordinate our communications. Next came a quick-fire list of logistical matters, which I scratched down in my notebook. Then, a list of ironclad rules for volunteering at Biocurious: do not be late or you will be fired; arrive 10 minutes early for your shift or you will be fired; if you are late or cannot make your shift, send an email to the biocurious-helpers address or you will be fired. Following the list of staff duties in the lab, Eri moved the discussion to the role of staffers in policing Biocurious.

Raymond rose from his IKEA chair to present again, telling us, "we want people to enter where it is controlled . . . the hardest thing about having a hackspace [*sic*] is having things all over hell and gone." In practical terms, he reiterated, this meant that all volunteers, members, and visitors must enter through the front door where they can be accounted for, and not through the back door where they might enter unseen. The only people who should enter through the back door were board members and volunteers on their way back from emptying the trash bins. Additionally, volunteers were not to take equipment donations without prior approval (from whom is yet uncertain).

Raymond now added additional duties to the volunteer ledger. During classes at Biocurious, the duty volunteer was to collect money and waivers from attendees before the class began and class evaluation forms after the class ended. Also, prior to each class, before it starts but after everyone has arrived, the duty volunteer was to give a brief presentation about Biocurious, issue instructions for classes, and answer any logistical questions that might arise.

Following the class briefing, Raymond gave us a few verbal directions that did not warrant their own slides, "If a reporter comes by and wants to talk to you tell them you need to talk to our media person . . . send an incident report . . . the incident report is kind of a catch-all to let everyone know what is going on." At this point, Kristina, the human resource specialist, took over from Raymond. She described the incident report as a special type of email communication, which went directly to the board and enabled any volunteer or member to communicate items of concern or information to the board. What the incident report is not, Kristina said, is gossip. Volunteers were not to gossip about members, other volunteers, or visitors on pain of termination.

In closing this catch-all portion of orientation, board member Josh Perfetto added, if fire or building inspectors come to Biocurious, accompany them and take good notes but "we [the board] prefer that inspections are scheduled with our safety officer."

Accompanying the discussion of daily duties was slippage between the terms volunteer and staffer. Kristina, Raymond, and Eri referred to us who assembled in the lab that day as volunteers when they discussed the future glory of Biocurious but as staffers when they discussed the day-to-day operation of the lab. Glory would belong to the volunteers who will help make

Biocurious the next Library of Alexandria, but consequences would adhere to staffers who take a wrong step. This section of orientation ended when Kristina stood and thanked us for having "the balls and ovaries . . . the courage to make [the lab opening] happen." Though that statement felt like a closing sequence, we had not yet addressed safety.

Brief Words on Safety

Just as I thought the long orientation was ending, safety officer Josh Perfetto stood up again and began enumerating the difference between Biocurious and other labs. He would like Biocurious to support users with skill levels ranging from beginners to PhDs. How he planned to do this was a bit fuzzy. Josh elaborated on the rule of thumb: "This is really about safety. We are not addressing ethics at all in this safety manual . . . Once the safety issues are satisfied, we are not going to tell you what to do."

He informed us, by reading from the safety manual he authored, that only BSL-1 materials can be used at Biocurious, but he was vague on what these materials are, noting only that materials must be well-formed and well-described. Well-formed by what standards and well-described by whom was passed over. Next, a list of banned activities was read: no PCR on pond water or cells from your own body. Members could work with well-characterized strains of bacteria but could not culture something found in nature. Mutagenic materials would be allowed in special circumstances, but the special circumstances went unmentioned. As Josh read the pre-printed safety manual in its entirety, we sat with copies in our laps.

When Josh finished reading, we all went on a tour of Biocurious with Kristina and learned how to lock and unlock the doors and stock the bathrooms. Our final action was to gather for a group photo (Figure 1.2).

Figure 1.2: Volunteer Orientation

After the photo, I am given volunteer key number one and a reminder that keys are the property of Biocurious.[6] When I returned home, I signed up for the first volunteer shift.

Left unmentioned during orientation was the legal and financial status of Biocurious. While a Meetup group requires minimal financial organization, opening a laboratory in Silicon Valley requires substantially greater organization and the attendant legal responsibilities. Was Biocurious a nonprofit organization? If so, was it operating under sponsorship or had the board filed paperwork with the Internal Revenue Service? And who, or what, was responsible for the lease? The financial portion of Biocurious was a mystery, yet felt unimportant. When you are altering the world, paperwork is beside the point.[7]

Making Sense of Orientation

During orientation, the board framed Biocurious as any new

[6] This key is still in my possession.
[7] Today Biocurious is a registered 501(c)(3) Public Charity with public IRS reporting requirement. Per Guidestar.org, Biocurious' stated mission reads: "We believe that innovations in biology should be accessible, affordable, and open to everyone. We're building a community biology lab for amateurs, inventors, entrepreneurs, and anyone who wants to experiment with friends." Biocurious is listed as having two programs, Community Projects and Membership. In the membership program description, Biocurious is described thusly: "BioCurious is a member-supported and volunteer-run community laboratory."

venture is framed, with a declaration of intent and set of instructions for materializing that intent. Volunteer orientation was the initial lecture of an education into actions suitable (Garfinkel 1967, 1996) in a "garage lab" whose aim is "to alter the world." This is not to say that I, or any other potential volunteer, anticipated the declarations or instructions given by the board. Like an unharnessed dynamo, unexpected ideas, comparisons, and detours came careening one on top of another at orientation.

Yet, from volunteer orientation, three dynamics slowly came into view. First, the board members declared Biocurious a new kind of laboratory, a “garage lab” created through, and enforced by, adherence to specific design principles, emphasizing the experience of science over the enunciation of scientific truths (Foucault [1976] 2002). Second, the board announced Biocurious as a site where the business of science would hew to the extra-vagrant practices of showbiz (Boon 2000), rather than the sober practices of the professional laboratory (Latour and Woolgar 1979). Members and visitors would experience the frontstage of Biocurious while volunteers would labor backstage. Third, the board announced Biocurious as a site where the elitism afforded scientific expertise (Turner 2001, 145-146) would be erased. In its place a new democratic form of science would be constructed -

stupid would be made OK. In a reaction that would prefigure many of the conflicts to come at Biocurious, the arguments made by the board at volunteer orientation received a mixed reaction from the assembled crowd. Of the fourteen potential volunteers at orientation only a four of us accepted the board's instructions for operating Biocurious and became volunteers. Here we can notice another truism of all new ventures: declarations and instructions are inevitably deliberated over (Varenne 2007; Allen 2015) and subject to adoption, rejection, or elaboration by those who live them out. The mass departure of potential volunteers following orientation was the first clue that deliberations over the dynamics established by the Biocurious board would be more difficult than the heady afternoon at orientation suggested.

I use dynamics, rather than themes or categories, purposefully. A dynamic process implies a set of constraints - a starting point, a guiding orientation, and a set of limits - which take the measure of an ongoing process. Within the limits of the dynamic established at orientation, Biocurious can be made visible as a particular type of institution: a “garage lab” of yet uncertain function. Past the limiting condition, the dynamic transforms into a new state of affairs. For example, actions suitable (Garfinkel 1967, 1996) during Biocurious’ Meetup phase were not always judged suitable in the “garage lab.” In positing a series of ongoing dynamics operating at Biocurious, I intend to forefront the work of attending to the approach and transgression of limits. That is, how the board at Biocurious instructed volunteers, members, visitors, potential regulators, and media audiences into their vision of "altering the world" through a "garage lab" and how they responded to efforts to alter their vision. The transgression of one limit, the aftermath of Biocurious' transformation from a nomadic Meetup group into a fixed laboratory, is the subject of this dissertation.[8]

The future of Biocurious, when I joined, was uncertain. Whether or not the “garage lab” would survive the first few months, and what form it might take a year out, were questions with unknown answers. The board members, volunteers, and members of Biocurious constructed Biocurious and instructed one another about what Biocurious was and was not as we went along. Volunteer orientation was one set of instructions for understanding Biocurious, but it was not the only set. New instructions from unexpected quarters would make themselves heard when the “garage lab” opened.

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[8] An everyday example of the phenomena I describe is the transformation of ice into water then into steam, accompanying the application of heat. Another example is Hegel’s metaphor of bildung as the transformation of a seed into a tree then into fruit, accompanying the application of instruction.

The following sections explicate the three dynamics in greater detail. While each of the three were played out at Biocurious, the first, the new kind of laboratory made material through a new design, was the primary dynamic. I will turn to the problem of design first.

Designing Biocurious

Biocurious is a biological laboratory designed for non-biologists. This is apparent in the design of the homemade laboratory benches, in the layout of the physical laboratory, in the board’s focus on branding and customer service, and in the design of Biocurious’s backstage approach to volunteer staff. On all levels, Biocurious’ design cuts hard against common sense notions of science. For thirty years the laboratory has been an oft studied venue within anthropology and Science and Technology Studies, yet there exists no record of a laboratory expressly designed for non-scientists. The laboratory is the domain of those contributory experts (Collins and Evans 2007) who wrangle secrets from nature. In this vein, the laboratory has been taken up as a site of experiment and knowledge construction (Lynch 1985; Amann and Knorr-Cetina 1989; Mody 2005), as a workplace (Shapin 1988; Lynch 1991; Gusterson 1996), and as a site where truth is enunciated (Foucault [1976]2002; Rabinow 1996). These studies have explicated how the work of science gets done in laboratories and associated venues (Collins 1974; Latour and Woolgar 1979; Knorr 1981; Star 1983; Lynch 1985; Galison 1997; Kohler 2002; Livingstone 2003).

Latour (1999), writing in the wake of twenty years of laboratory studies, takes stock of the laboratory literature and points to the unique form of political power the laboratory wields as a direction requiring more attention. Latour (1999) conceptualizes the laboratory as a lever, a force pushing handcrafted facts produced inside a laboratory into the outside world through a series of displacements which magnify in force as the distance between laboratory and displaced fact increases. In this way, even the smallest laboratory or most inconsequential fact can create outsized effects in the world.[9]

If volunteer orientation demonstrated anything, it was that the board members of Biocurious were intent on causing outsized effects in the world by displacing the material and symbolic fact of the laboratory itself. Their vehicle of transformation was

[9] One example of the outsized political effects a laboratory can have in the world is Winch's ([1958] 2007) discussion of Pasteur's discoveries ushering in hand washing as a medical norm. To not wash one's hands, post-Pasteur, was to declare oneself unfit for medicine.

design.

Design is a difficult and deceitful concept. Flusser (1999,17) argues that the etymology of design derives from a constellation of words around cunning, is associated with traps and snares, and operates through trickery. Flusser also reminds us that the etymology of design reaches deep into the history of all European languages. Any attempt to invoke design, therefore, risks signifying too much and reaching out in too many directions. To come to grips with the design of the laboratory at Biocurious, some hemming in is in order.

The constellation of words wrapped within design include technology, arts, and craft. In contemporary use, design is coterminous with plan or planning and co-enrolled with making, engineering, and doing in the business of constructing new economies and technologies. Yet Flusser (1999,17-20) reminds us that an old meaning of design (de-sign) is the process of marking out, or signifying. This is the action taken before inscribing a new pattern, or form, on a substrate. It is the part of planning prior to making, engineering, or doing. And here we can note that design is de-signifying, in the sense of erasing what was prior.

On this point, Latour (2008,5) explicates two aspects of design that are helpful in hemming in the concept. First, all design is redesign and there can be no ex nihilo design. Second, design implies an ethical dimension. That is, a design can be better or worse. To Latour's observations we can add two more, noticing that any design signifies and instructs in more directions than it intends. In this sense, designs are extra-vagrant (Boon 1998), promiscuously associating with related concepts, and only restrained with difficulty. We can also note that what Law and Mol (2008) have called "material politics," i.e. political arrangements left latent in materials such as speed bumps, share the quality that Flusser (1999,20) noted of the plastic pen - the wily and cunning crossing of domains and boundaries engendered by design obscures the workings of design.

Recently, anthropology has addressed the workings of design in multiple registers. Design practice, in the sense of redesign with an ethical dimension, has been put forth a model for a future anthropology (Rabinow et al. 2008; Murphy and Marcus 2013; Gunn et al. 2013). The relation between anthropology and design has also been explored in terms of a design anthropology (Gunn and Donovan 2012) and in terms of anthropology as an adjunct to design practice in applied contexts. Much of the latter work is in keeping with the long history of design studies (Rittel and Webber 1973; Simon 1996; Nelson and Stolterman 2003) which posits design as a hybrid discipline uniquely situated to speak across the science-humanity divide. Another direction has seen

(Nicewonger 2013) design taken up as a unique educational practice, a topic initially broached in the pedagogical writings of Donald Schon (1984; Schon and Wiggins 1992).

Accompanying this multiple engagement with design has been a call for an anthropological interrogation of design in the contemporary world. In a framing article, Suchman (2011) has called for an anthropology of design that critically addresses the work of design in positing and enforcing prospective futures. Like Suchman (2011), Ingold (2012) calls attention to the rough ground between setting out prospective future arrangements through design rules or languages and the business of living out those prospective arrangements. Murphy (2015) examines the work of design in Sweden and finds that design reproduces and furthers traditional Swedish values by operating across boundaries and through time to connect traditional values with prospective futures. All of these anthropologists conceptualize design not as an inert object, but as active process subject to ongoing deliberations (Varenne 2007) over prospective uses. Following up this line of thought, Anusas and Ingold (2013,66) urge anthropologists to refrain from conceptualizing stable objects and instead conceptualize objects and materials as "a tapestry of interwoven lines."

If the last decades have seen several lines of thought about design emerge within anthropology, Flusser remains the theorist who has most aggressively pushed design and classically Boasian concerns about the meaning of new knowledge (Boas 1887; Kroeber 1940) closest together. Per Flusser (1999), the prototype of all cultural action is the lever. The substitution of an artificial arm for a natural arm is the first cause of culture, since the arm as lever is the prototype of all forms of artificiality. Flusser (n.d.,19) notes that even a simple design such as the lever is trans-mechanical, stretching across and over the laws of mechanics. Designs are, therefore, forms of utopic thought which necessarily overflow narrow application to spill into other intellectual operations. Note two elements of Flusser's thought. First, the lever cultures by producing new knowledge that cannot be avoided. Second, the concrete reality (the precept) of your arm precedes the cognitive sense (the concept) of leverage. A lever, like all design, is a tool that conceptually evokes possible futures and concretely functions as a substrate to appropriate and elaborate upon. The fate of any new design (gesture, action, etc.), as Garfinkel (1996) notes of all "screwing around," is to be erased or taken up and developed through deliberation (Varenne 2007).

Presenting Biocurious

As I mentioned earlier, the day I entered Biocurious ended with a BBC camera crew walking into the lab as I was leaving for the day. Far from being an isolated incident, the business of showing Biocurious was a regular chore for all involved with Biocurious. Board and monthly members regularly talked to media outlets, regulators, corporate sponsors, and policy researchers about the activities of Biocurious. Volunteers regularly showed Biocurious to visitors contemplating becoming members and to the many people who wanted to tour "the next big thing out of a Silicon Valley garage."

Volunteer orientation was self-consciously concerned with Biocurious as a brand. The actions of volunteers and members at Biocurious were to be in the service of communicating a strong brand identity, and as will be made clear in later chapters, the design of the “garage lab” was intended to convey the same message about Biocurious. Branding is a recent topic of anthropological interest that has been approached from a number of perspectives. Often branding has been taken up in semiotic terms. Nakassis (2013) has argued that branding is best understood as a dialectic between commodity and surfeit, in the tension between a fixed meaning and an excess of signification.

Manning and Uplisashvili (2007) put forth a material-semiotic theory of branding. Here a brand signifies and constructs a larger social imaginary in which the brand also constructs its place. Luvaas (2012) describes how the Indonesian DIY fashion industry is able to subvert globalized brands by using their trademarks and logos to expose the labor of production hidden behind the singular image of the brand. Together, each approaches a peculiar aspect of late capitalism: one present at volunteer orientation in the board's consistent focus on the power of customer service and branding as leverage to produce an image of Biocurious as a “garage lab” capable of moving out of the lab and displacing existing practices of laboratory science.

While branding is a relatively recent coinage, the backstage work of producing a frontstage effect is an older process that has gone hand-in-glove with the movement of science and technology out of laboratories and into wider use. Within the STS literature, this process has often been framed in terms of translating and associating (Callon 1986) loose interests into stable semiotic-material networks of people (actors) and materials (actants). As the work on branding referenced above demonstrates, people and materials are not easily cajoled into accepting stable meanings.

The lengths scientists will go to in order to cajole people and materials into order was the subject of Latour’s 1983 history of Pasteur’s microbes. Latour (1993) wrote of Pasteur: "if Pasteur stays too long inside his lab," his research will remain nothing more than an interesting curiosity in the history of science, or a footnote to a possible future. Hence pressure mounts on Pasteur to demonstrate the efficacy of his laboratory discoveries in a manner the press can convey to French publics, popular and scientific. In response to this pressure to demonstrate the efficacy of his laboratory, Pasteur holds a public demonstration of his work in a pasture. In Latour's (1993) terms, Pasteur harnesses his will to that of the public by enrolling them through his use of the media as an intermediary. As part of the demonstration, Pasteur predicts which cows shall live and which shall die. And the marked cows did die, along with public doubt about Pasteur's methods. On one hand, Pasteur's pasture experiment is a public demonstration of expertise, hence a step along the way of translating his laboratory work into the wider world. Another way of understanding Pasteur's pasture experiment, one confluent with volunteer orientation at Biocurious, is as an exercise in creating a strong brand and media presence around Pasteur's lab.

Similarly, in a study of Edison's development of incandescent light, Bazerman (2002) finds Edison at work in his laboratory managing his lab’s emergent discoveries, in the patent office managing the industrial reception of his lab’s discoveries, and in the popular press managing the presentation of his lab’s discoveries. Edison carefully works his vision of a future lit by the incandescent light bulb through overlapping discourse networks, creating a vision and demand for a future anchored in the present that will only appear through Edison’s successful acts of symbolic engineering. Thus, prior to the material form of the incandescent light comes a symbolic arranging which cajoles the various discursive networks into place so that the incandescent light bulb can be recognized as a work of genius.

In involving the public with the media as intermediary, an element of showbiz is necessary. Edison does not have to engage in the particular form of symbolic engineering (Bazerman 2002) that he does in arranging for incandescent light, nor does Pasteur have to arrange an experiment in a pasture (Latour 1993) to prove his point. These examples of symbolic engineering contain what Boon (1998) referred to as the extra-vagrant quality of all cultural productions, in that they stretch the truths of light and microbes past the demands of their demonstration. As with Flusser’s lever and the cavalcade of ideas that accompanied volunteer orientation, Edison and Pasteur’s presentations were less exercises in efficient translation and branding than examples of the extra-vagrant wanderings of the scientific imagination.

In its extra-vagrancy, the business of showing takes on the qualities of spectacles and exhibits. Boon (2000,430) notes that like bricolage (Lévi-Strauss 1966), showbiz "makes sense from loose ends and bits." Unlike bricolage, showbiz also "blatantly festoons," "deflates grandiosity," and "undercuts sanctimoniousness." In the case of Biocurious, the showbiz of orientation functioned to deflate and undercut the sanctimoniousness of those elite scientists who made Biocurious board members feel stupid. Like Barnum, showbiz's best exponent, who Boon (2000,426) calls a "democratic educator," the business of showing Biocurious is public instruction into a near future that prominently features "garage labs" sharing the marquee with academic and industrial laboratories.

Boon (2000) argues that showbiz and cultural production share the quality of shifting, sliding, and straddling over, around, and across boundaries. As Flusser (1999) argues of design, for Boon, all cultural productions are transmechanical and all meaning making activity is extra-vagrant in its wanderings. To this we can add that the extra-vagrant wanderings of demonstrating and designing must be brought to heel by ongoing deliberation (Varenne 2007).

Democratizing Science at Biocurious

If the design of the laboratory was the primary dynamic unveiled at orientation, an associated dynamic was the board's desire to democratize science. Few places mark the distinction between amateur and professional as strongly as the laboratory. As Latour and Woolgar (1979) noticed in the Salk laboratory, the first thing one notices in a laboratory is the visual distinction between those in coats authorized to work at the lab bench and those who are not authorized. The boundary visually indexed by the lab coat is undergirded by a less visible, but no less concrete, web of schooling, certification, and class. It was precisely this web of certifications, class, and schooling in science that the board announced would be turned upside down in Biocurious's "garage lab."

Within STS, the study of expertise came into being as studies of the first generation of laboratory studies were getting underway. Many studies of expertise have taken up the complex ways in which amateurs are able to successfully contest and challenge scientists outside of the laboratory (Wynne 1989; Epstein 1995). These studies forced expertise to be seen as a relational concept in which expertise was situated within a particular context and was employed to particular ends. But in the laboratory, an environment designed for experts, scientists face no outside challenge to their expertise.

But even in the laboratory, gradations of expertise can be discerned. Collins and Evans (2007) have developed a taxonomy of expertise stretching from what they call ubiquitous expertise, what everyone knows, to contributory expertise, what allows scientists to create new knowledge. Of particular interest are the experts possessing what Collins and Evans (2007,30) call interactional expertise. These are experts with linguistic competency (they speak the language) in a specific domain of knowledge. Per Collins and Evans, interactional experts are responsible for cross-pollinating scientific domains and help to introduce new techniques and ideas into existing scientific practice.

There were many interactional experts at Biocurious: volunteers and members with contributory expertise in business or a science other than biology who spoke enough biology to translate Biocurious to visitors, corporate sponsors, the media, and potential regulators. These interactional experts acted to glue Biocurious together through a combination of bricolage and showbiz.

But with expertise comes the problem of extension, the question of who may participate and speak with authority in a domain of knowledge. Per Turner (2003,12), the problem of extension requires that figuring out who has and who doesn't have expertise can only be accomplished through debate and discussion. But this point leads to a further complication: expertise is only recognizable by a core of other experts. Expert knowledge is non-communicable (Turner 2003,140) and those without expert knowledge lack the grounds to properly judge the quality of expertise.

Any attempt to democratize science threatens to run afoul of the paradox Turner identifies. Those who are not contributory or interactional experts in a scientific domain (Collins and Evans 2007) find it difficult to discern what constitutes science.

A further difficulty for those who seek to democratize science was identified by Dumont (1980). Writing on the question of hierarchy and value within anthropology, Dumont identified a paradox, similar to paradox of expertise identified by Turner, in that all attempts to eliminate hierarchy through egalitarianism must inevitably substitute a new hierarchy for the old. The human condition, Dumont (1980) argues, is either constant conflict over status or the acceptance of a complex etiquette which holds hierarchical relationships in place through decorum.

Conclusion

Chapter One took up the board's vision at orientation as both a declaration of independence from the norms of the academic laboratory and as a set of instructions constituting and organizing Biocurious as a "garage lab." Orientation introduced the board's vision of Biocurious to the initial assembly of potential volunteers, a vision complicated by the dynamo-like generation of ideas and possibilities at orientation. In this vein, the instructions given by the board at orientation were analyzed as three dynamics. First, around the design of the laboratory at Biocurious. Second, around how Biocurious was to be demonstrated to its public. Third, around how science was to be democratized at Biocurious.

Further, this chapter argued that interpreting and enforcing the design of the laboratory, demonstrating Biocurious to various publics, and managing the numerous interactional experts in and around Biocurious all generate an extra-vagrancy (Boon 2000) of meaning, requiring ongoing deliberations (Varenne 2007) over suitable next steps.

Chapter Two situates Biocurious within the history of both Silicon Valley and the broader DIYbio movement. It begins with a history of Biocurious prior to the Sunnyvale "garage lab" and ends with a history of the wider DIYbio movement.

Chapter Two

"The Next Big Thing Out of a Silicon Valley Garage"

Overview

Chapter Two situates Biocurious within both the history of Silicon Valley and the history of DIYbio movement. The opening section narrates a prehistory of Biocurious before the "garage lab." The section details how Biocurious' roots extend back to an Arizona warehouse, the circumstances under which Biocurious found itself in a Mountain View garage, Biocurious' time as a nomadic Meetup group, and finally how Biocurious came to open a laboratory in Sunnyvale rather than Mountain View. Following the history of Biocurious, the next section recounts a brief history of the Santa Clara Valley, situating Biocurious in a line of "new things" emerging from Silicon Valley garages. After situating Biocurious within the history of Silicon Valley, a history of Biocurious in relation to DIYbio is developed. At this point an overview of the popular and academic literature on DIYbio, important in establishing a history of DIYbio, is undertaken. The literature review takes pains to emphasize the relationship between DIYbio and academic synthetic biology. The chapter then shifts gears to address the history of safety precautions around genetic engineering, comparing the tenants of the 1976 Asilomar Conference on genetic engineering and safety to recently drafted American and European Creeds for DIYbio. Close attention is paid to the American Creed's dynamic tension between the liberty of an individual to experiment and the collective responsibility of all for ensuring safety. Finally, a note on method and position are presented.

Biocurious before the Garage

In the years prior to opening the "garage lab," a series of elective affinities came together for Biocurious. The 2008-2009 recession led to a large number of layoffs and liquidations in the biotech sector and an ongoing overproduction of research PhDs nationally, leaving many PhD-level researchers in Silicon Valley without a clear career path.[10] Particularly hard hit were the middle class of the biotech world: laboratory technicians who were experienced in the ordinary business of working in a

[10] The downfall in biotech came after the massive investment in biological infrastructure sanctioned by California Proposition 71, which had poured 6 billion dollars for stem cell research into building out laboratory infrastructure in California over the previous decade (Benjamin 2013).

laboratory. In sum, experimenters, equipment, and space were all available in abundance when Biocurious needed them.

The story of Biocurious begins in Bruce Rittman's lab at Arizona State University (ASU) with a PhD student funded by Aubrey de Grey's SENS Institute.[11] John Schloendorn was a computer scientist with an interest in de Grey's theories of aging. To further his interest, he decided to pursue a PhD in biology. Rittman, head of the Biodesign Institute at ASU, provided the SENS-funded Schloendorn with lab space, institutional certification, and supervision. As a side project during his PhD work in Rittman's lab, Schloedorn opened a small lab in a warehouse (a “garage lab” of sorts) nearby to pursue a personal research program. It was at the warehouse that John met Eri Gentry.

Eri and John eventually moved to a condo in Mountain View, California where they began to informally experiment on cancer cells obtained from an unknown source. As one does in Silicon Valley, Eri initiated a biology Meetup in the condo's garage.

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[11] The SENS Institute is devoted to studying life extension with the goal of eliminating death. All inquiry into life extension begins with a heretical idea that aging and disease are the product of intracellular waste accumulation and that disease can be arrested by cellular rebuilding: a process similar to replacing parts on a car as it ages. Needless to say, this idea is currently a mis-take within biology.

Meanwhile, John bought and sold laboratory equipment on eBay to support himself and purchase equipment and supplies for both of them. Numerous old-timers, those who had been around Biocurious from the Meetup days and were still active when I was doing field work, recounted being discovered by Peter Thiel and a group of venture capitalists while holding an early meeting in John and Eri's garage.[12] In the telling recounted to me by several early members, Thiel heard about Biocurious through the Silicon Valley grapevine (Silicon Valley at this level resembles a small American town where gossip and personal relations count for more than balance sheets and intellectual property) and using deductive reasoning and Google Maps, determined that the only garages in that area must be in the complex where Eri and John lived. Thiel then drove around the area until he found the right garage. The story is a Silicon Valley folktale of genius recognizing genius. And it is with Thiel's entrance into John and Eri's garage that Biocurious became a Silicon Valley myth. It is worth noting that Thiel’s visit was the point where John and Eri went their separate ways. Eri stayed with the Meetup group while John’s startup was funded by Thiel. This would establish a dynamic of commercial ventures being organized at Biocurious and

[12] Peter Thiel is a cofounder of Paypal and a well-known venture capitalist.

then moving out of Biocurious.

Biocurious existed as a wandering Meetup group after leaving John and Eri's garage.[13] The group met here and there in Silicon Valley and the surrounding area in a series of picaresque adventures in biology. One month, the discussion topic was crushing wine grapes from a chemical perspective, and another month they screened a documentary about synthetic biology. It was during the Meetup period that support, interest, and media attention were gathered prior to the “garage lab” opening. The Meetup period also established the kind of interests and social status those interested in Biocurious membership would have. Participating were those interested in the chemical aspects of winemaking with the time, means, and inclinations to experiment themselves, or at least to drink and talk. And it was during this Meetup phase that the other original board members - Tito Janikowski, Josh Perfetto, Joseph Jackson, Raymond McCauley, and Kristina Hathaway would join Eri.

The Meetup phase helped to generate interest for a crowdfunding campaign to fund a public lab opening. Biocurious became one of the first successful crowdfunding campaigns on

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[13] Meetup.com is an essential part of the 21st century life in Silicon Valley. It allows the formation of associations based on expressed interest in a manner de Tocqueville would certainly recognize.

Kickstarter when 239 people contributed $35,319 (52 people contributing between $100-$500) in September 2010.[14] The Kickstarter campaign was conducted under the auspices of Joseph Jackson's Network for Open Scientific Innovation, a 510(c)3 corporation capable of taking tax deductible contributions, and the Kickstarter tagline hewed to the innovation tact:

> Come be a part of the next big thing to come out of a Silicon Valley garage! Curious about Biology? Find out more at the new biology collaborative lab space where citizen science moves out of the classroom and into the community. Following the successful example of hackerspaces such as Noisebridge, Langton Labs, Hacker Dojo, and co-working spaces such as the Hub, we're pleased to offer the first Bay Area space dedicated to Non-Institutional Biology. Got an idea for a startup? Join the DIY, "garage biology" movement and found a new breed of biotech. Meet cofounders and friends, and make things you'd never dreamed possible.

During the crowdfunding campaign the lab was imagined and explained to potential backers to be a hackerspace with member input in governance. A garage collective. And like all novel technology developed via bricolage in one's garage, and unlike technology engineered in corporate and academic laboratories, Biocurious was to be IP neutral.[15] Technology developed at

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[14] The Kickstarter campaign is archived at https://www.kickstarter.com/projects/openscience/biocurious-a-hackerspace-for-biotech-the-community/description

[15] IP neutral meant that as policy, Biocurious would not seek an equity stake in any invention created or company started at

Biocurious was to stay with the inventor.

Finding the laboratory equipment necessary to equip a “garage lab” was easy. In the Meetup days of 2010 through 2012, there was enough surplus laboratory equipment around the Bay Area that television stations regularly advertised biological equipment auctions. In addition to eBay and local auctions, swap meets featuring lab equipment and lab consumables were monthly occurrences.

If gathering a core of interested members via Meetup, raising enough money to open via Kickstarter, and acquiring laboratory equipment were simple enough tasks, finding a local municipality willing to allow a "garage lab" operate within city limits proved to be more challenging. After several time-consuming appearances before the Mountain View city council, Biocurious' petition to open a "garage lab" in Mountain View was rejected. Almost a year after the successful Kickstarter campaign, Biocurious opened in neighboring Sunnyvale. Sunnyvale is only a few short miles south of Mountain View, but those miles were enough to put Biocurious out of easy reach for many, as the Sunnyvale location is far from the nearest rail hub. As well, the

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Biocurious. This policy contrasts with policy at most other laboratories, academic or commercial, where an equity stake is often the price of entry.

few highway miles between Mountain View and Sunnyvale add up to a significant amount of time during the evening commute.[16] And the evening commute was most important element governing weekly participation at Biocurious, with most members who were active multiple days of the week living no more than 15 minutes away via automobile. Finally, after overcoming multiple obstacles, in late summer 2011, Biocurious was primed to open a “garage lab” in a low-slung office building at 843 Stewart in Sunnyvale, California.

A History of the Santa Clara Valley in Two Monikers

From the declaration - "this is a new thing in the world" - made at volunteer orientation to the lessons in innovation passed down by Silicon Valley old-timers to novices, the centrality of Silicon Valley in contemporary life was a constant companion at Biocurious. In this telling of Silicon Valley, people believe they can make history into circumstances of their own choosing by disrupting, displacing, and erasing what came before.

[16] During the rush hour, it might take an hour to drive what is, at other times, a ten minute drive.

Figure 2.1: Map of the Clara Valley

Source: http://dotspotting.org/

Consider this 21st century map of the Santa Clara Valley's transportation net. Biocurious is located within the yellow X.

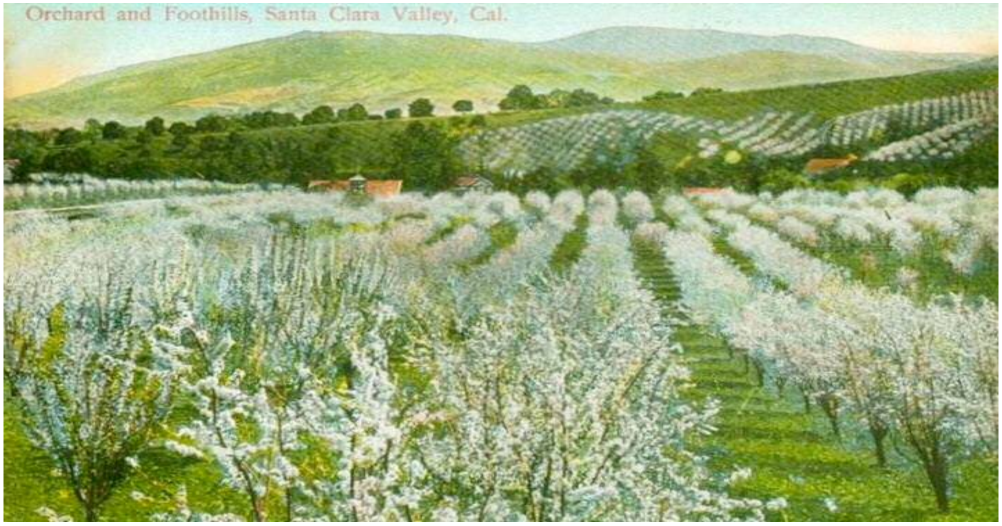
The Valley of Heart's Delight

Biocurious sits in what is formally known as the Santa Clara Valley. The valley acquired the name Santa Clara in 1777 when Junipero Serra established the Mission Santa Clara de Assisi in the center of the valley.[17] In the 1830s, Mexico subdivided the

[17] For the prior ten thousand years, the valley had been occupied by the Ohlone people.

Santa Clara Valley into a series of ranchos as an impetus to the economic development of California, giving rise to the broad pattern of development still visible today in the corporate campuses and subdivisions of San Jose, Santa Clara, and Sunnyvale. Economically, the ranchos experiment was a success. Even the change in ownership of the Santa Clara Valley during the Mexican-American War did little to slow the course of economic development set in motion by the ranchos experiment. For the next century, the Santa Clara Valley would quickly move towards more intensive agricultural production based around large tracts of farmland carved from the original ranchos, starting with cattle ranching in the 1830s, then moving to grain production in the late 1850s, and finally arriving at peach and cherry production in the 1890s. The valley was fortunate to have two natural advantages in this regard - a nearly perfect climate for growing stone fruit and plentiful clean water.

Figure 2.2: The Valley of Heart's Delight



Source:
http://www.mariposaresearch.net/santaclararesearch/

In the late 1890s, the Santa Clara Valley acquired the moniker "Valley of Heart's Delight" for the vast orchards of peaches and cherries which covered the Santa Clara Valley with pink and white blooms every spring.[18] By the 1930s, the Santa Clara Valley had established itself as the world's largest producer of canned and dried stone fruit. The valley had risen to the top of the agricultural pyramid with fields in full bloom and factories at full tilt. This feat was made possible by the

[18] Per "The Origins of the Silicon Valley" (http://www.sjsu.edu/faculty/watkins/sivalley.htm), the moniker was bestowed by Lord Kitchener on a visit.

development of an agricultural machinery industry churning out insecticide sprayers, water pumps, and industrial grade canning equipment. Much of this equipment was developed by inventors laboring in the garages of subdivided San Jose and Sunnyvale. But following the high tide of the 1930s, the pastoral form of life poetically named by Lord Kitchener would collapse.

The Second World War transformed the Santa Clara Valley in two ways: through an infusion of government contracts which forged enduring technical and social ties between the Santa Clara Valley and the American military and through the construction of military infrastructure. The war also completed the transformation of the valley from a pastoral landscape to an industrial landscape that was started, somewhat ironically, by the agricultural machinery industry, as agricultural companies pivoted to lucrative military contracts.[19]

In the post-war period, the Santa Clara Valley would be transformed by the confluence of government funding, the ambitions of Stanford scientists and administrators, and the entrepreneurial initiative of people like Hewlett and Packard. A

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[19] An excellent example of this transformation is the case of the Food Machinery Corporation. It was founded in 1883 to manufacture a piston pump for insecticide sprayers, evolved to manufacture canning equipment in the 1920s and 1930s, then moved to manufacture the amphibious vehicles used in the Pacific Theatre during the Second World War.

pivotal moment in this transformation was the founding of Fairchild Semiconductor in 1957 by the "traitorous eight," a group of eight recent PhDs who left the Shockley Semiconductor Lab en masse to found Fairchild. Following the establishment of Fairchild, the Santa Clara Valley quickly became the world's premier producer of integrated circuits and integrated circuit manufacturing companies. The group that left the Shockley Lab would eventually found more than sixty companies, including the two largest integrated chip makers, Intel and AMD.[20] It was Fairchild's success in initiating a new industry that legitimized the swashbuckling approach to tradition, regulation, and business that have come to be associated with Silicon Valley startups.

Silicon Valley U.S.A.

By late 1970, chip factories in the Santa Clara valley were at full tilt, but startup activity was beginning to wilt. When Don C. Hoefler published a newsletter about "the fledgling rebels" of Shockley Transistor, he complained that although they

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[20] Hoefler produced a well-known chart (http://corphist.computerhistory.org/corphist/documents/doc-45ff3e214d9ea.pdf?PHPSESSID=89ad1d889a28ce5a1a26d8a9b6cf2d4b) illustrating the relatedness of the companies founded by the Fairchild Eight. The chart accounts for companies formed through alliance and through descent.

had created 23 companies since leaving Shockley fifteen short years earlier, the four new companies established during 1970 made 1970 "not a vintage year for semi-conductor startups."

Figure 2.3: Silicon Valley USA

SILICON VALLEY U.S.A.

(This is the first of a three-part series on the history of the semiconductor industry in the Bay Area, a behind-the-scenes report of the men, money, and litigation which spawned 23 companies — from the fledgling rebels of Shockley Transistor to the present day.)

By DON C. HOEFLER

It was not a vintage year for semiconductor start-ups. Yet the 1970 year-end box score on the San Francisco Peninsula and Santa Clara Valley of California found four more new entries in the IC sweeps, one more than in 1969.

The pace has been so frantic that even hardened veterans of the semiconductor wars find it hard to realize that the Bay Area story covers an era of only 15 years. And only 23 years have passed since the invention of the transistor, which made it all possible.

For the story really begins on the day before Christmas Eve, Dec. 23, 1947. That was the day, at Bell Telephone Laboratories in Murray Hill, N.J., three distinguished scientists, Dr. John Bardeen, Dr. Walter Brattain and Dr. William Shockley, demonstrated the first successful transistor. It was made of germanium, a point-contact device that looked something like a crystal detector, complete with cat's whiskers.

The three inventors won the Nobel Prize for their efforts, but only one of them, Dr. Shockley, was determined to capitalize on the transistor commercially. In him lies the genesis of the San Francisco silicon story.

It was only by a quirk of fate, however, coupled with lack of management foresight, that Boston failed to become the major semiconductor center San Francisco is today. When Dr. Shockley left Bell Labs in 1954, he headed first for New England to become a consultant to Raytheon Co., with a view toward establishing a semiconductor firm there under its auspices.

*Source:*http://www.computerhistory.org/atchm/who-named-silicon-valley/

This brief report on the 1970 startup season is best remembered for coining the now familiar moniker, Silicon Valley. Like Lord Kitchener's moniker, Hoefler's phrase captures a feeling in the Santa Clara Valley at the zenith of an industry. Implicit in Hoefler's review of 1970 is the new speed at which digital business moved in the Santa Clara Valley. The valley no longer moved to the yearly rhythm of agriculture, or the quarterly rhythm of industry, but rather to the increasing tempo of the digital age. It should be no surprise then that the Homebrew Computer Club (henceforth HCC) would hold its first meeting in Gordon French's Menlo Park garage four short years after Hoelfler's coining of "Silicon Valley."

In French's garage, the integrated circuit would be harnessed to information technology in a new form: the personal computer. From humble beginnings in French’s garage, the members of the HCC would create the personal computer (PC) industry by binding existing technologies into a new shape. The PC industry, like so many others in the Santa Clara Valley before it, was born and incubated in garages both literal and metaphorical. In 1983, at the tail of the semiconductor industry in Silicon Valley and the tip of the emerging PC industry, Richard E. Schmeider, a former geography professor, produced an address guide for sales people making cold calls in Silicon Valley. He drove several thousand miles and spent $150,000 to produce the first detailed map of electronics companies in Silicon Valley. Much to everyone's surprise, rather than the hundred or so electronics companies widely thought to be doing business in Silicon Valley at the time, Schmeider found over eleven hundred, most being small teams in anonymous office parks, toiling away in the privacy of their metaphorical garages.

Biocurious in the Shadow of Industries Past

Figure 2.4: Superfund Sites

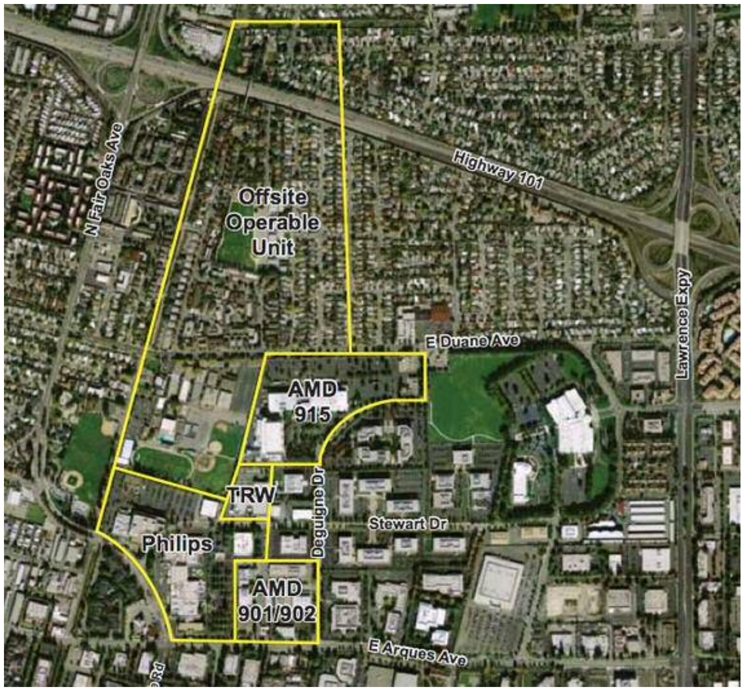
*Source:*https://toxmap.nlm.nih.gov/toxmap/

The 21st century landscape does not give up many clues, but Biocurious is surrounded by Superfund sites (represented by blue dots in the map above). In the 2013 Atlantic article "Not Even Silicon Valley Escapes History" that was heavily discussed at Biocurious, Alex Madrigal notes that Silicon Valley, and particularly the Biocurious' central location, is a post-industrial landscape comparable to Detroit. In a clever conceit, Madrigal uses Schmeider's map as a travel guide to the Silicon Valley of 2013. Driving Schmeider's route, Madrigal discovers that unlike industrial-era Detroit, industrial-era Silicon Valley has managed to recreate itself anew. While the lives, careers, business, and addresses of the mid 1980s have been erased and replaced with low-slung office parks reminiscent of college campuses, their remnants linger in the form of Superfund sites.[21] The streets and office complexes once home to the bubbling workshops and metaphoric garages of Schmeider's guide have been erased and replaced. Like the design and redesign of Flusser’s (1999,19) plastic pens, the design and redesign of the Silicon Valley landscape is rarely noticed.

Biocurious sits in the geographic center of Silicon Valley amid the ruins of its most iconic companies. The Superfund sites represented by blue dots on the map above include some of the most famous Silicon Valley companies of the first generation, including Fairchild Semiconductor as well as Fairchild's offspring, Intel and AMD (Advanced Micro Devices).

[21] Superfund is a special designation authorized under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. A Superfund designation denotes a site where hazardous material requires environmental remediation. See Fortun (2012;2001) on post-industrial geographies and the afterlife of industrial pollution.

Figure 2.5: A Street View of Superfund Sites



Source: https://toxmap.nlm.nih.gov/toxmap/

Moving to a street view of the map brings the extent of the pollution surrounding Biocurious into clearer view. Biocurious sits at the corner of Stewart and Deguigne. The AMD sites marked above, as Madrigal notes, are contaminated with tricholoroethene (TCE), a Volatile Organic Compound (VOC) commonly used in manufacturing. In what is known as the "Triple Site" in Sunnyvale, which Biocurious sits astride, there has been concern in the past few years that TCE has leached up from the contaminated groundwater plume and become an airborne toxin. Industrial toxins leached into the groundwater (38 wells were ultimately affected) at the AMD site have been subject to ongoing cleanup efforts since 1983. Most recently, the cleanup has been effected through bioremediation, using molasses among other things. Aside from the obvious point about redesiging the world through bioengineering, Madrigal's article dovetails in another important sense with the conception of history suffusing Biocurious.

In Silicon Valley, design is a tool through which prospective futures can be actualized and troublesome bits of the past erased. In Chapter One, two critical approaches to design emphasizing the political dimensions of design were introduced. Latour (1998) who has argued that all design is intertwined with an ethical standpoint, and Flusser (1999) who has argued that design has the quality of a trick, or a con game. Silicon Valley, however, has a natively developed theory of design. A whiggish history of the role of design in Silicon Valley (Katz 2015) both exemplifies and explains the theory. In his history of Silicon Valley, Katz interprets the history of Silicon Valley as a march of progress borne of the back of clever design. At the end of the march, Katz (2015) takes stock and finds design, in forms ranging from industrial design to design thinking, a handmaiden in service of corporate strategy. In particular, employing design and designers enabled the startups of Silicon Valley to stop relying on government contracting and corporate sales and move directly to creating consumer demand for new technology. Within Silicon Valley, design is seen as the means of creating and recreating the technological bleeding edge, creating a present perched between the nostalgia of futures past and futures yet to come.[22]

In this spirit, in an email to the Biocurious Google group, a Biocurious board member took umbrage to the thrust of Madrigal's description of Silicon Valley as a post-industrial landscape awash in past toxins.

Figure 2.6: Board Member's Response to Madrigal

> This was a really fun article to read but the basic premise is so flawed. There are DIYbio labs, Planet Granites, Chinese evangelical churches, strip clubs, and self-storages in other areas that are not superfund sites. This guy (from where?) basically averages some geospatial data and takes a lot of significance in the exact mean, walks around, sees things he's never seen before like indoor rock climbing, cannot "parse the neighborhood", finds a historical factoid, and ascribes all causality to it.
>
> It was an industrial zone before it got polluted and it is an industrial zone now. It is bad that this happened and it is

[22] Vogt (1955,90) in an ethnography of New Mexico homesteaders (sponsored by Clyde Kluckhohn as part of the Values Project) notes that the New Mexico homesteaders "believe in a chance (the future) which can be outguessed and outmaneuvered." Vogt notes that natural phenomena are handled through increasing automation even in cases where automation is neither efficient nor practical. Here, too, the idea of design or progress through automation is evident.

getting cleaned up, but it is not really that big of a deal day-to-day. People in Sunnyvale don't need to drill backyard wells. This area and the superfund sites in Mountain View are hardly the cheapest areas around. It was an interesting hypothesis but he didn't do anything to test or validate it. He just wrote about it really well to make it sound like it must be right."

Consider the inability to "parse the neighborhood" in the midst of change. The objection that "people in Sunnyvale" do not need to drill backyard wells indexes the changes brought by the redesign of the Santa Clara Valley. Per the board member's sensibilities, post-industrial pollution is a non-issue, an industrial variation of the shellmounds that still dot the Santa Clara Valley. A past future that has given way to the more glorious future on the horizon.

Sunnyvale’s infrastructure reflects the design and redesign of the Santa Clara Valley. The water supply, for example, is a mixture of agrarian and industrial. One does not need to drill a personal well in Sunnyvale anymore, yet a percentage of Sunnyvale's municipal water supply comes from older agrarian wells drilled decades prior. Similarly, a generation ago the garage attached to a single family home was an inescapable part of suburban life in Sunnyvale, just as a farm workshop was a generation prior. Today, a garage is a luxury item as the single family houses of the past give way to the condos and apartments of contemporary Sunnyvale.

Yet the board member's objection that the Superfund cleanup effort "is really not that big of a deal day-to-day" is true. And his objection also indexes a point of continuity in the midst of consistent change. Madrigal's failure to find obvious traces of a lost golden age in the valley belies the greater truth of Silicon Valley; the golden age is the age on the horizon.

Biocurious in the History of DIYbio

If Biocurious is a creation of Silicon Valley, it is also an artifact of the emergent DIYbio (short for Do-It-Yourself Biology) movement. DIYbio is a recent invention, though its historical precursors stretch back to at least the 1956 Symposium on Information Theory in Biology (Yockey 1958), where DNA was first equated with information, and organisms were first addressed as information sources. While the intellectual ground was cultivated decades before, the outline of the form DIYbio takes today did not come into relief until the comparison between DNA and computer programming was made explicit: a development coinciding with the diffusion of the internet from the tight circles of academia into the everyday life of non-academics.[23] While the laboratory is an obvious and crucial historical antecedent, DIYbio as it came to be practiced at Biocurious was heavily reliant on the norms and tools of software development in order to design and model bits of DNA to be assembled in a "garage lab." In this sense, we can consider the DIYbio laboratory a space analogous to Gordon French's garage. That is, a space where two disparate disciplines are cobbled together to an uncertain end.

The proximate emergent of DIYbio was presciently identified by Rob Carlson, who pronounced the era of biology as a manufacturing platform to be at hand in the IEEE Spectrum (2001). Carlson mused that biological understanding and tooling had progressed to the point where molecular biologists had developed a kernel of biological understanding that would enable an army of tinkerers to innovate new services on top of the kernel, using design tools derived from software development. Here, the implicit comparison is to the development of the open source operating system Linux (Coleman 2001) with its kernel and services model of development. Carlson's vision was of a core of

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[23] The internet is an excellent example of stimulus diffusion (Kroeber 1940), being everywhere the same and yet everywhere different.

experts - computer scientists or molecular biologists - developing the platform required for an army of amateur designers to innovate over.

Writing for the popular magazine *Wired* four years after, Carlson (2005) proclaimed that the era of "garage biology" had arrived; laboratory equipment could be purchased on eBay, protocols, like so many recipes, for performing important lab task could be found on Google, and MIT was rumored to be a few months away from releasing a genetic parts library to the general public. The picture painted by this pair of matched articles written four years apart is of biology transformed into a programmable substrate. The silicon chip reborn in the biological cell. Most importantly, Carlson argued in the pages of *Wired* that, like the Homebrew Computer Club started in Gordon French's garage, "the necessary skills [for DIYbio] may be acquired through trial and error."

While Carlson was addressing the world of entrepreneurs and garage tinkerers in order to recruit them into a speculative new industry to be formed around biological manufacturing, in other Silicon Valley venues, the hacker ethic (Levy 1984) was quickly asserted in the biological realm. Perhaps growing out of the nascent hackerspace movement (hackerspaces.org), as early as 2005, Meredith Patterson had introduced the concept of biohacking to computer hacking circles within San Francisco. By 2008, Jason Bobe and Mac Cowell working in Boston had launched the website diybio.org with a blog post titled "Don't Phage Me, Bro" in which they wondered aloud if DIYbio could be the next Homebrew Computer Club and drew on the makerspace startup Techshop as a model for organizing amateur biological inquiry. In 2011, keeping with the old proverb that journalism is history's first take, Marcus Wohlsen published *Biopunk: DIY Scientists Hack the Software of Life*, an account of North American DIYbio movement during the period from 2008 to 2010. The book describes a glorious future surely around the corner; Wohlsen gives us a story of charismatic outsiders on the verge of ushering in a radically new future in which biology becomes both a universal machine in the same manner as a computer and the substrate for a new manufacturing economy. Hence, by 2010, DIYbio was represented in the popular press and engineering journals as a synthesis of the information economy and the industrial economy. It was the next big thing. And it was during this period that the FBI initially became interested in DIYbio.

Following close on the heels of the initial manifestos and journalistic accounts came academic literature. In 2010, an Outlaw Biology Conference was convened by Christopher Kelty at UCLA. There, Patterson unveiled "Biohacker Manifesto" in which she asserted that biological inquiry is a political right and biohacking a political act. In a paper given at the same conference, Kelty (2010) offered a typology of participation in DIYbio. Kelty distinguished three possible positions within DIYbio: outlaws existing outside the scientific system, hackers working to reconfigure the system from within, and Victorian Gentlemen above the system. While the 2010 Outlaw biology conference inaugurated academic work on DIYbio, the ensuing years have seen academic work into DIYbio's origins and affinities expand in quantity and scope. Tocchetti (2012), for instance, finds a direct precursor of DIYbio in *MAKE: Magazine*. To the extent to which DIYbio hews to the *MAKE: Magazine* model, Tocchetti finds DIYbio following in the myth of "grassroots American innovation." In contrast to the many decidedly American historical precursors, Kera (2012,3) describes DIYbio labs in Europe and Southeast Asia as growing out of existing cultural and art centers and resembling the spaces envisioned by Leibniz for the Academy of Sciences. Biological hackerspaces, Kera argues, are making good on Liebnitz's theory of a scientific academy that brings into being new ecologies, new sets of relations, new networks of knowledge, and new forms of participation in science and related knowledge practices. To this end, Kera draws a comparison between the emergent DIYbio networks and Latourian "cosmopolitics." Delfanti (2011) finds DIYbio's success in its symbolic, rather than scientific, import. It represents a more horizontal, personal approach to research compared to the industrial scale projects typical of academic and industrial biology. On the physical location of DIYbio labs, Meyer (2013) notes that DIYbio labs are primarily located in urbanized European and US urban spaces adjacent to academic institutions, finding these urbanized spaces within a well-developed communication ecosystem. Between labs, blogs, email, and other electronic tools are widely used to share findings, ideas, and to coordinate political action.[24] Meyer (2013) also points to the open source hardware designs produced by DIYbio as hybrid objects through which the development of DIYbio can be understood. Delgado (2013) echoes Meyer's note on the unfinished nature of DIYbio projects, arguing that within DIYbio, "things are always becoming."

Safety Through Elitism

Between the 1955 Symposium on Information Theory in Biology and the emergence of "biohacking" as a term with consequences,

[24] I would add that in this aspect, DIYbio communication resembles academic grey literature.

the 1975 Asilomar Conference on Recombinant DNA was convened in the interest of arresting the diffusion of experiments on recombinant DNA.[25] The final section of the conference's summary statement (Berg et al. 1975,1984), "New Knowledge" addresses the responsibilities of contributory experiments (Collins and Evans 2007) in the new age of recombinant DNA. The instructions given in "New Knowledge" remind the biologist that a biologist should carefully collaborate with colleagues in the related fields of infectious medicine, microbiology, and ecology to ascertain the potential dangers of recombinant DNA beyond the laboratory before proceeding to experiment with DNA. The final section calls upon professional biologists to arrest the potential diffusion of recombinant DNA off its narrow base of biological experts by keeping the process of recombinant DNA closely held by the contributory experts who understand the promises and perils of novel creating DNA sequences.

The history of recombinant DNA between the boundaries inscribed by the Asilomar conference and Carlson's 2001 declaration that the age of biological manufacturing was at hand is beyond the scope of this dissertation. But one consequence is

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[25] Recombinant DNA is DNA that has been artificially created from multiple genetic constituents. In this way, novel DNA sequences with novel functions can be reliably created.

as inescapable for DIYbio as it was for Asilomar scientists, experimenting with DNA demands that one move from the clean world of technical procedures to the rough ground of ethics.

Ethical Creeds for DIYbio

While differences and commonalities between DIYbio labs and equipment have been discussed in the academic literature, two comparative codes of ethics produced by DIYbiologists during matching Europe and North America conferences in 2011 are highly illustrative of how European and American conceptions of DIYbio diverge. While the European code was produced at the London School Economics BIOS Center in conjunction with representatives from DIYbio labs from several European countries. The North American code was produced in San Francisco, whereabouts unknown, in conjunction with members of six DIYbio labs.[26]

Figure 2.7 European Code of Ethics

Transparency Emphasize transparency and the sharing of ideas, knowledge, data and results. **Safety** Adopt safe practices. **Open Access** Promote citizen science and decentralized access to

[26] See: www.diybio.org/codes

biotechnology.

Education

Help educate the public about biotechnology, its benefits and implications.

Modesty

Know you don't know everything.

Community

Carefully listen to any concerns and questions and respond honestly.

Peaceful Purposes

Biotechnology must only be used for peaceful purposes.

Respect

Respect humans and all living systems.

Responsibility

Recognize the complexity and dynamics of living systems and our responsibility towards them.

Accountability

Remain accountable for your actions and for upholding this code.

Compare Table 2.2 above with the American of code of ethics in table 2.3 below:

Figure 2.8 North American Code of Ethics

OPEN ACCESS

Promote citizen science and decentralized access to biotechnology.

TRANSPARENCY

Emphasize transparency, the sharing of ideas, knowledge and data.

EDUCATION

Engage the public about biology, biotechnology and their possibilities.

SAFETY

Adopt safe practices.

ENVIRONMENT

Respect the environment.

PEACEFUL PURPOSES

Biotechnology should only be used for peaceful purposes.

TINKERING

Tinkering with biology leads to insight; insight leads to innovation.

Present in the European code but missing from the North American code of ethics are modesty, accountability, community, and responsibility. Present in the North American code but absent in the European code is the right to tinker with DNA as the DIYbiologist desires.

Thus the North American DIYbio code of ethics marks an explicit move away from the precautions put forth at the Asilomar Conference on Recombinant DNA (Berg et al. 1975), precautions implicitly present in the European Code of Ethics - also the product of an academic conference. The differences might be summed as follows: in Europe what is not expressly allowed is forbidden, and in North America what is not expressly forbidden is allowed. Allowed might be too mild a descriptor. It is more accurate to say that exploiting what is not explicitly disallowed in North America is expressly celebrated. To act suitably in North American DIYbio, one must not wait for permission. In rejecting precautions (even the moderate precautions of modesty , accountability, community and responsibility), the rules of recombining DNA within DIYbio have been made confluent with the unstated rule of Silicon Valley.[27]

As well, there is an older and more familiar tension between the right to tinker and the call for decentralized access to biotechnology. This tension is expressed by the paradox of expertise Turner (2003) discussed in Chapter One. This paradox is particularly evident around the issue of safety in DIYbio. As the last section noted, the Asilomar compromise on safety relied on contributory experts (Collins and Evans 2007) to police themselves. But Biocurious and other DIYbio labs intent on democratizing science and extending (Turner 2003) access to genetic engineering necessarily redesign (Latour 2008,5) the Asilomar principles for safety in genetic engineering. Just how Biocurious redesigned safety protocols will be discussed in the chapters ahead.

A Note on Problematic, Method, and Position

The linear ordering of Biocurious' history and its place in the Santa Clara Valley was intentional. It was done to clearly mark the point at which I enter Biocurious as a distinct moment in which Biocurious was transformed. But the incomplete nature of Biocurious when I entered demands that before proceeding, I make

[27] The rule is pithily summed up in Mark Zuckerberg's famous exhortation to "move fast and break shit."

a methodological detour to account for my participation in the Biocurious project. When I entered, Biocurious was transitioning from a nomadic Meetup group into a stable laboratory. The fluidity of interaction allowed by the Meetup format was giving way to more institutionalized forms of interaction required by the move to a fixed space. Decisions made just prior to and just after the opening had unexpected, yet ramifying, effects for all involved. As it will become evident over the next few chapters, I was a key participant in many of those conversations.

Method is the process through which theoretical concerns are made concrete. I take the point of a methods section to be a report of the operations I undertook to perform my analysis, starting with my entry into the field and continuing through to my formulation of the dynamics used to effect the analysis. This description is not a laundry list of prepacked methods which I applied against a stable and known object of inquiry; and in this case, it cannot be such a list. Rather, I offer the following brief encapsulation of the interactional theory guiding this dissertation:

> This is an orchestration for an event. For a dance in fact. The participants will be apprised of their roles at the proper time. For now it is enough that they have arrived. As the dance is the thing with which we are concerned and contains complete within itself its own arrangement and history and finale there is no necessity that the dancers contain these things within

> themselves as well. In any event the history of all is not the history of each nor indeed the sum of those histories and none here can finally comprehend the reason for his presence for he has no way of knowing even in what the event consists. In fact, were he to know he might well absent himself and you can see that that cannot be any part of the plan if plan there be (McCarthy 2010, 342).

Biocurious is the event with which we are concerned. And Biocurious, as an interactional achievement by those inside and outside of the institution, is the unit of analysis here. As an institution, Biocurious, like Holden's dance, has ramifying effects on those who participate in its making. It is not necessary that the members of Biocurious contain within themselves the history of Biocurious. Biocurious is complete within itself. The history of Biocurious cannot run in any direction other than forward; a retrospective sum of histories offers no hope in understanding or explaining the reason for anyone's presence.[28] What one can do is bear witness to the event and one's role in bringing it into existence.[29]

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[28] Nor, as Holden demonstrates to the kid in the closing pages of *Blood Meridian*, does representing a dance via the soft determinism of historicism or psychology absolve one's responsibility for participating. Once underway, there can be no escape from events.

[29] I want to emphasize here that in Shapin and Schaffer's (1989) elucidation of witness in Boyle's experimental program, the witness serves as both a constituent of and commentator upon the experiment. I was both a constituent of and commentator upon the

Within the social sciences, the methodological difference between ex post facto representation and the ongoing constitution of social action has been most powerfully elucidated in the ethnomethodological literature. Most clearly, the difference was explicated by Weider (1988) in his ethnography of a halfway house. Weider contrasts ex post facto representation, which he compares to the voiceover from a travelogue, with "telling the code." In the travelogue mode, readers are made to travel through space and time with the comfort of a social scientist to narrate their progress and contextualize their experiences. Explanations of the action within the film strip are exogenous to the people represented. As Weider (1988) argues, "one hears the narrative as an outside commentary on events depicted visually." The reader and the social scientist are outside of, and absent from, the scene of action.

Weider contrasts the travelogue approach to "telling the code" at the halfway house he studied. He writes that "telling the code" was not simply commentary on a situation, a exogenous gloss given from afar; rather, it was the process of "telling the code" that constitutes the situation it serves to describe. Weider notes that the code "was at the same time part of life in

orchestration of the experiment in organizing biological inquiry called Biocurious.

the halfway house, and it was a part that was itself included within the scope of things over which the code had jurisdiction. It is in this sense that talk involving the code was reflexive within the setting of its occurrence."

Similarly, commentary from volunteers, members, board members, and visitors to Biocurious on the emerging rules of Biocurious was not exogenous commentary upon Biocurious; their talk both constituted Biocurious and commented upon Biocurious.

When I entered into Biocurious, I stepped into a set of emerging relationships, which inscribed a double move that witnessed the ensemble of people and things at Biocurious apprenticing into a new and uncertain way of doing biology, and myself apprenticing into anthropology. Throughout the two years of my fieldwork, my Biocurious consociates and I talked, deliberated, acted, and through these ongoing conversations and actions constructed Biocurious. My anthropology consociates and I did the same. Interactions and deliberations begun by a handful of people in a Mountain View garage continued throughout my fieldwork and continued on with a new cohort of members, volunteers, and board members today.[30]

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[30] As Holden noted of the paradox between presence and absence, one cannot escape being present and hence, implicated, when events are under construction.

Technical Matters

In a laboratory, quite a bit of the talk revolves building equipment to support analysis. The other part of lab work is working up protocols which serve as replicable instructions between equipment and analysis. My explication in this section includes both my construction of analytic equipment and protocols as well as the modifications, *mutatis mutandis*, required to apply them to my material.

Field notes were taken on my laptop into plain text files. This was arrived upon as a strategy due to the ubiquitous of the open laptop at Biocurious. They were in every room, every day Biocurious was open. In contrast, notebooks were a relative rarity and an object with special status as laboratory notebooks. Of course, jottings and notes taken outside Biocurious were recorded in notebooks. I also experimented with taking field notes by using a smartphone voice application to transcribe audio recordings of my narration into text files which then were forwarded to my email. Though promising, this technology had to be abandoned as I could not discipline myself into speaking in a machine parsable manner.[31] Laboratory work was recorded using a

[31] At Biocurious, I met a member who had worked on a precursor of Microsoft Cortana, a voice-based personal assistant application.

small video camera with a flexible tripod that allowed the camera to be mounted directly on laboratory benches and other equipment. This proved to be an efficient way to mount the camera in a place which would not draw undue attention.

More difficult than the mechanics of recording field notes, interviews, meetings, and lab work was the issue of how to efficiently collate the vast array of electronic communication generated by Biocurious. I solved this problem by using a web application "If This Then That" to route emails from multiple addresses and tweets to an Evernote account. All materials were then imported into a ConnectedText wiki which served as a content management system, allowing easy indexing and retrieval of information and facilitating analysis.

Conclusion

This chapter opened with the history of Biocurious before the "garage lab." After narrating the twists and turns that led from an Arizona warehouse to a Sunnyvale office park, Biocurious

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His speech pattern was remarkable in that his tone, intonation, and pace in face-to-face conversation was that of the Cortana application. When I asked about this, he informed me that years of working on computer speech had left him the ability to easily switch into this register.

was situated within the history of both Silicon Valley and the DIYbio movement. While the board’s positioning of Biocurious as “next big thing out of a Silicon Valley garage” in media accounts of Biocurious would be a constant, the departure of one of the original Biocurious founders would suggest that moving out of Biocurious, rather than Biocurious itself, was “the big thing” at Biocurious.

At this point, a review of the academic and popular literature on DIYbio emphasizing its relation to academic synthetic biology was developed. Following that, a brief history of efforts to ensure responsible safety measures for DIYbio, beginning with the 1976 Asilomar Conference on Genetic Engineering was narrated. In the course of this history, a marked difference between ethical codes for DIYbio developed in the United States and Europe was highlighted. This difference was identified as a tension existing in the American creed between the individual’s liberty to tinker and communitarian demands for safety. Finally a note on method was presented.

Chapter Three through Six present present the core ethnography of this dissertation, and each addresses particular facets of the dynamics outlined in Chapter One. Chapter Three begins the cycle with an analysis of the design language operative at Biocurious.

Chapter Three

From Garage to Lab By Design

Overview

Chapter Three addresses how Biocurious was produced through an explicit design language intended to render Biocurious recognizable as a "garage lab." That is, as a particular kind of institution producing a particular kind of scientist. This chapter also raises the question of who visited, volunteered at, and joined Biocurious. These questions are further examined via a discussion of media policy and corporate sponsorship at Biocurious. In doing so, the chapter foreshadows the conflicts between membership and the board of Biocurious discussed in Chapter Four. Next, the chapter examines how the incident report was used by the board at Biocurious. Rather than using incident reports to report singular policy violations, incident reports were most often used by the board to collectively discipline volunteers for deviating from the evolving set of instructions for volunteering. The chapter draws to a close by examining the case of a long-term volunteer banished from Biocurious via action coordinated through an incident report written by a board member.

A Design Language for Garage Biology

At orientation, comparing the Library of Alexandria, Edison's machine shop, and the Hewlett Packard garage with Biocurious supplied a not-so-subtle hint that the board thought of Biocurious in world-historic terms. The narrative presented at orientation was couched in mythic terms and described Biocurious as both the culmination of a long history of invention and as the precursor of a glorious future just coming into view. Comparing the volunteers at orientation to an elite on par with "Olympians and Rangers" simply reinforced the myth. These comparisons were not as unusual as they might appear. Similar comparisons are common in Silicon Valley startups. At Biocurious, mythic elements served as instructions for members, volunteers, visitors, and those experiencing Biocurious through the media in understanding Biocurious' place within Silicon Valley. Biocurious was, as the Kickstarter tagline read, "the next big thing to come out of a Silicon Valley garage."

I stress the importance of media audiences of, and visitors to, Biocurious at this point because in 2011 and 2012 Biocurious became a Silicon Valley tourist attraction where visitors could observe citizens-scientists working in a laboratory with homemade benches and improvised equipment. Visitors could even join closely curated scientific demonstrations by signing up for an afternoon or evening class. One could observe “the next big thing” and have a taste of it as well.

As will be argued in the following sections, the concerns of those working at Biocurious came second to the concerns of those being shown Biocurious. This was not a secret. The idea was clearly communicated at orientation as the difference between front stage and back stage activities and in the commitment to "doing good customer service." What was not made clear was that the front stage did not include all members and volunteers at Biocurious. The board preferred visitors to be shown particular types of volunteers and members and sought to move less preferential types of volunteers and members out of Biocurious.

Attempts to tightly control experiences, and thus engender new ways of seeing and understanding, have a long history within science. Bazerman's (2002) examination of Edison's efforts to bring incandescent light to the marketplace through the mobilization of discourse networks to symbolically engineer the conditions for the incandescent bulb and Latour's (1993) description of Pasteur's pasture demonstrates are cases in point. On a smaller scale, Jack (2009) has argued that Robert Hooke’s program of microscopy contained a “rhetoric of sight” design to instruct the reader in a particular manner of understanding the microscopic scale and Shapin and Schaffer's (1989) examination of Boyle's literary technologies is the classic example of carefully cultivated scientific understanding.

The laboratory at Biocurious was designed for viewers of a certain class and sentimental disposition to view Biocurious as the latest in a long line of Silicon Valley startups that have "altered the world." And the future Biocurious was designed to make visible was a future where biology has become a technology on the order of the personal computer, a future where DNA can be edited like computer code, a future where novel organisms can be created by anyone with minimal technical skills, and a future where personalized medicine has eliminated genetic disease and arrested the aging process.

Though it was not made explicit in any of the numerous internal and external materials Biocurious generated, there existed a set of design principles adhered to closely in the design of laboratory at Biocurious, in the layout of the classroom space, and in the board's approach to managing volunteers. One of the board members, the most active board member at the lab in the early days of Biocurious, elucidated his vision for Biocurious to me one afternoon. This was a vision at odds with the vision of some board members and most members and volunteers at Biocurious. The principles were also purposively at odds with the design of academic and industrial laboratories. Yet this design language was operative in all aspects of Biocurious from the design of the interior spaces to the workings of the board.

The board member's vision was of a laboratory inviting to newcomers, which can be surveyed at a glance by a lab manager.

Figure 3.1: Clean Sightlines

The overarching principle was that every object in the lab be transparent and easily monitored. Like all panopticons (Foucault [1976] 2002), transparency was the overarching design principle connecting the interrelated parts of the lab - the grand design of which was visible from a particular organizational position (that of a board member) but invisible elsewhere. Visually, the design emphasized clear sightlines (Figure 3.1) extending from the classroom through the laboratory taking in at a glance the full sweep of people, work, and materials in the lab.

Storage boxes are transparent so the contents can be easily monitored and supplies easily refreshed. The classroom is furnished with reconfigurable furniture - there were three sets of configurations depending upon the activity expected. Laboratory bench tops are made of whiteboard material so notes can be written on them during classes or experiments. The board member offered that the idea behind transparency was not so much to observe what members are working on, but rather to make restocking the lab with consumables as simple as possible.[31]

Technically, what the following represents can be considered a design language.[32] A design language is a set of aesthetic

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[31] The idea of a transparent laboratory with individual cubicles as an alternative to private laboratory space was invented by Carl Duisberg at the Bayer laboratory during the 19th century development of the synthetic dye industry in Germany. Ironically, the transparency was intended to stop scientists from hiding discoveries and moving them out of the Bayer umbrella following the theft of the dye "Congo Red" by a Bayer researcher. Of course, the IP neutral stance at Biocurious mattered little when everything was easily observable.

[32] The academic literature on design languages is curiously absent given their ubiquity in the designed environments most of

concepts which produce a concrete effect by making some activities visible and rendering others invisible. In this sense, the design of Biocurious goes beyond a simple reading of Biocurious interior aesthetics (one member derisively called the interior design style "late IKEA") and connects sightlines of the laboratory to the questions of who may work on what in the laboratory, who may observe this work, and how this work is made visible as the work of a "garage lab.[33] Importantly, the design language laid out below worked in conjunction with the behavioral instructions to volunteers given at orientation to produce an effect on visitors to the lab, an effect which emphasized the proper mis-en-scene for a garage poised to produce the "next big thing." Everything was to be in its place and not scattered "all over hell and back" as the volunteers were warned at orientation.

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the world now works within. A powerful example of a design language is the "snow white" language developed by Frog design in the early 1980s, which was associated with Apple products of the 1980s. Currently, Apple uses a design language inspired by the Bauhaus movement and first used industrially by the Braun corporation in West Germany. These design languages have been used to distinguish Apple from other PC makers and to evoke a feeling of individuality and creativity in Apple's consumers. To gauge the effectiveness of these design efforts, I direct the reader to any university lecture hall

[33] Though never explicitly described as a panopticon, the principle of observation underlying Bentham's structure is entirely confluent with the design language at Biocurious. Unlike Bentham's imaginary prisoners, the board of Biocurious had to make do with a boxy office building unsuited to easy observation and volunteers and members whose actions often contradicted board members' wishes.

Figure 3.2: Biocurious' Design Language

1) The space is designed architecturally to give an effect of openness and cleanliness. Visitors should feel welcomed when they enter the space. Cleanliness is all important as no hint of contamination or sloppiness should be seen or felt by visitors. The visitor experience should be pleasant and frictionless.

2) The tables and benches are designed so that the entire space can be surveyed from any point in the room. Maintaining lines of sight from end to end between the classroom and laboratory is important. There should be no space left unseen. The laboratory, in this sense, opens to the visitor and invites them inside.

3) There is no division between the front of the lab and the back of the lab, or physical division between the class space and the lab space. This is in keeping with the emphasis on clear sight lines that give an impression or cleanliness and order.

4) Everything on the lab is on wheels, even equipment that should not be wheeled. The idea behind this principle is to allow the lab to morph into different configurations based on different activities - classes, meetings, individuals in the lab. The homemade lab benches at Biocurious are not on wheels but are light enough for two people to move easily.

5) All containers are transparent, from the virtual containers within the organization holding information on volunteers, members, and visitors to the physical objects in the space. This was described as a democratization issue and intended so that everything in the lab was easily observable by anyone at anytime. This was taken as far as securing an old film refrigerator with a glass door.

6) Lab surfaces are lab-grade but can be drawn upon with dry erase markers. The homemade lab benches are topped with white board material so protocols can be written down and calculations performed for all to see.

7) Beakers are to be color coded to simplify for newcomers. This was an idea never implemented at Biocurious, but it speaks to the thought that went into making the laboratory experience approachable for newcomers and visitors.

8) The lab, and all future Biocurious labs, should contain a

Quantified Self library, as the board member remarked, "isn't it time for libraries to become more like Techshop?" Techshop is a makerspace that both lends out tools and holds classes in their use.

Backstage at the Laboratory: Wi-Fi, Heat, and Startup Life

Though volunteer orientation promised visitors and members an experience somewhere between Disneyland and the Library of Alexandria, the lab sat empty through the fall of 2011, and my volunteer shifts were boring affairs which found me sitting alone at a desk in a cold, dark, and empty office building. I sat quietly in the reception area and waited for a visitor or one of the dozen or so lab members to arrive. My field notes from this period contain many doodles and extended observations on the behavior of the squirrels and blue jays who called the front landscaping home. The lab was used during this time for occasional organized classes held during the evening hours and by Meetup groups on the weekends. Only a handful (perhaps two or three) members used the lab for labwork during the fall of 2011 and then only sporadically, not methodically, and often late at night after the lab was ostensibly closed for business and the last volunteer had left.[34] Yet, Biocurious was determined to be

[34] Ostensibly, only volunteers and board members were to have keys. Practically, many members found quiet ways to obtain keys.

open to the public eleven hours a day, so I worked many shifts starting at noon and continuing into the evening.

Visitors during the initial fall at Biocurious tended to be engineers who wanted a tour.[35] Being up on the bleeding edge of technology is an essential social skill in Silicon Valley, and visitors were fairly common on weekday evenings. One evening about a month after opening, a man who introduced himself as the IT guy at Kiva stopped by for a tour. After taking the tour and asking the usual questions about the difficulty of experimenting, the learning curve for biology, the cost of membership, and the operating hours, he sat down on a couch in the reception area to do some work while waiting for rush hour traffic to subside.[36] A few seconds later, he told me that the Wi-Fi situation at Biocurious was unacceptable. Without hesitation, he asked to see our internet router. I walked with him to the backroom and where the router was located, he quickly took in the make and model of the Biocurious router judging it “all wrong,” then drove to the local Fry's (less than 5 minutes away by car) and bought Biocurious a new internet router. In the spirit of boredom and

[35] Occupation was easy enough to discern as visitors were required to fill out an information sheet prior to being allowed out of the reception area.

[36] Traffic would be an ongoing barrier to participation at Biocurious. Commutes were measured in minutes, not miles. Phrases such as, "I live ten minutes away" or "my commute is ninety minutes" were common.

the North American Code of Ethics, I allowed him to replace the router. He installed the router and then proceeded to play his ukelele for the next two hours. He never reopened his laptop. When the next volunteer on duty arrived, the two of them sang and played in the reception area.

When the new router was discovered, I was given a mild verbal reprimand by a board member. While there was no incident report generated, I was reminded that staff did not have the authority to change infrastructure at Biocurious and that I had also moved chairs to the reception area when they belonged in the classroom area. In the parlance of Biocurious, I had not "reset" the lab to its default layout. There were no actual consequences, likely because I was the only person who worked the unpopular Monday afternoon shift and there was always a shortage of volunteers.

While activity during the weekdays was sporadic at best, weekends attracted a regular software Meetup group based around learning a popular and lucrative technology.[37] This Meetup group was of particular importance, as it was run by a well-known programmer and attracted a core group of software developers who

[37] There was also a children's science class on Saturday afternoons. I occasionally was asked to assist in experiments such as mixing Mentos and cola on the front lawn and making ice cream with liquid nitrogen. These experiments were great fun.

reliably paid full membership dues simply to use the classroom once per week. Despite having many offers of free meeting space from well-known Silicon Valley companies, the Meetup was held at Biocurious as a favor to one of the board members. It was an open secret among the members and volunteers that with the lack of members interested in working in the laboratory, the Meetup group covered expenses and bought Biocurious time while membership was built up.[38] A programmer could come to the Meetup twice for free, but had to join Biocurious at the member fee of $100 per month upon attending a third meeting. In exchange for this, the group asked for a fast Wi-Fi connection and a comfortable meeting space.

Despite the Kiva engineer's router upgrade, which was replaced with the original router a week later, the Wi-Fi connection at Biocurious was still slow. Not only was the Wi-Fi slow, the routing equipment refused to support more than a handful of connections simultaneously. As a result, the Meetup group struggled to run their tutorial problems together. Adding to the frustration, it was growing colder by the day but nobody had yet bothered to turn on the heater.

As the volunteer on duty when the Meetup group met, Saturday

[38] Biocurious' finances remained as mysterious as ever. Just how many members we needed to sign up to cover the rent and utilities was never divulged to my knowledge.

afternoon, I was on the receiving end of complaints about infrastructure failures and responsible for relying those complaints to the board. I also had the responsibility of representing the board, at least in some small way, to the Meetup group. Early in the fall, one volunteer was named volunteer coordinator, and all volunteers were instructed to report problems directly to the volunteer coordinator. Thus, enough bureaucracy sprung up within a few months of opening, despite having no more than two members actively working in the laboratory, that as a "normal" volunteer I could no longer relay complaints directly to the board. However, this did not prevent me from receiving complaints directly from the Meetup group. Like so many interns and office workers in Silicon Valley and elsewhere, I was left in the position of receiving complaints that I could not rectify and relying on a suspect bureaucratic mechanism that regarded complaints and those transmitting them as suspect.

These nagging problems transformed into a crisis through a series of infrastructure failures during the fall and winter of 2011. After a few months of intermittent internet access, the Meetup organizer demanded that the internet be fixed and that I inform the board in no uncertain terms that this is a demand, not a request. What started as a minor problem has developed into a crisis as his Meetup group had grown. The crux of the current problem was that the Wi-Fi connection at Biocurious could not support more than a handful of simultaneous connections. There was no resolution to the Wi-Fi problem. By the early spring of 2012 the Meetup group relocated to a large corporate office at a well-known tech company with working Wi-Fi and abundant heat. The exodus of so many paying members led to a minor financial crisis, the consequences of which will be taken up in Chapter Four.

What Kind of Scientists?

The presence of a design language at Biocurious begs the question: Who is the laboratory designed for? Given that the design of the laboratory deviates in several important ways from commonly accepted laboratory design - primarily in the wheeled, transparent storage and homemade lab benches - it quickly became apparent the laboratory was not designed for traditionally trained scientists. Reinforcing the divergence, when speaking of Biocurious' future to visitors at the lab, board members often pointed to the success of Techshop as a model for Biocurious to emulate.[39] Like Techshop, Biocurious was supported by a

[39] Techshop is a commercial makerspace whose business model relies on sponsored equipment and classes in conjunction with paid membership. During the first year of Biocurious' existence,

combination of membership fees and corporate classes and sponsorships. As I hinted at in the previous section, the design of the laboratory was intended for these corporate visitors to view Biocurious as "the next big thing." This appeal to corporate customers was helped by the backgrounds of the board members, at least one of whom had significant fundraising experience with corporate donors.[40]

If traditionally trained scientists were not the main beneficiaries of the design language, then who was? The table below breaks down the number of people at Biocurious in its first thirteen months of operation from September 2011 through October 2012. The categories are internal to Biocurious. In the tracking system at Biocurious, these categories were employed to track who was, and who was not, actively participating. Each category has certain associated rights and responsibilities, which will be discussed over the next few chapters.

First, few preliminary explanations are in order. Board members were members who sat on the board of Biocurious (even

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Techshop was often in the news for its rapid expansion. As well, many Biocurious members were also Techshop members.

[40] On one occasion in fall 2011, I was involved in a conversation with another volunteer and a board member about creating a corporate educational retreat for executives interested in biotechnology. The retreat would feature several planned activities at Biocurious. These preliminary plans would have required volunteers to drive corporate executives back and forth from the airport.

though Biocurious' legal status was an open question during the first two years). Lifetime members were members who contributed a substantial amount during the Kickstarter campaign of 2010 and were awarded a lifetime membership to Biocurious. Annual members were members who received a discount on monthly membership by paying a discounted lump sum amount at the start of the year. Monthly members paid their dues monthly. Expired members were monthly or annual members who were in arrears with their dues, or who had paused or cancelled their membership. Active volunteers were volunteers who regularly worked a shift, be that shift daily, weekly, or monthly. Expired volunteers were volunteers no longer regularly working shifts.

Fellowships were a special type of membership awarded for a set period. While I was at Biocurious, the only people receiving fellowships were the winners of the Thiel Fellowship who received a complimentary membership at Biocurious for the length of their Thiel Fellowship in Silicon Valley.[41] Visitors were people who came to Biocurious for a class or to receive a tour.

[41] See: http://thielfellowship.org/.

Figure 3.3: Persons at Biocurious

Category	Total
Members	
Board Members	6
Monthly Members	30
Annual Members	5
Lifetime Members	8
Expired Members	17
Volunteers	
Active Volunteers	23
Expired Volunteers	20
Fellowships	5
Visitors	1,367

Figure 3.3 refers to a visitor log kept at Biocurious and covers the period between September 2011 and October 2012. As the table makes clear, the vast majority of people coming to Biocurious were simply there to visit or take a class. Visitors to the lab included many local professors and PhD students as well as industry researchers and engineers from local tech companies. Also among the visitors were numerous media outlets and a member of a White House committee on innovation, who, while on a listening tour of Silicon Valley, stopped by Biocurious to listen to the concerns of a select few lab members. The number of board members remained constant at six (the youngest half holding Ivy League degrees), but both members and volunteers experienced a churn rate of about 50%. As well, some members were simply ceremonial and not active in the laboratory. As a practical matter, this meant that at any given moment, Biocurious consisted

of six or seven volunteers and a matching number of members to operate the space and manage the flow of visitors.

Like all involved in the daily work of Biocurious, volunteers and members at Biocurious tended to come from the surrounding towns of Sunnyvale, Mountain View, Palo Alto, San Jose, and Santa Clara. A few volunteers came from outside the immediate vicinity, but they were the exception. Many volunteers were students at local universities, others came from local Meetup groups and other civic associations, and still more came to Biocurious by way of friendships with board members, other volunteers, or members. Members at Biocurious were drawn from a narrower pool. Where volunteering required a low invested of money, being a member required a constant stream of lab materials to be ordered and required time outside Biocurious to study biological theory and practice lab technique. Hence, members active in the lab tended to be economically comfortable middle-aged men who either had technical backgrounds in biology or engineering or had worked in the hardware or software industry. The most active members tended to be retired engineers, scientists working on proof of concept experiments, and serial entrepreneurs looking to found biotech startups. The demographics at Biocurious differed little from the wider demographics of Silicon Valley.

The Media and Policy Audience

Not reflected in the table is the most important audience for Biocurious, those who consume media and policy reports about the laboratory. In the first year, Biocurious was featured in the *New York Times*, the BBC, and several other international news outlets. In addition, a feature was run by *Wired*, the magazine of record in Silicon Valley, and articles were written by all the local newspapers.

An example of the genre that ran a few short weeks after the lab opened was an article appearing on the Singularity Hub website on October 14, 2011. This article describes Biocurious as a community of more than five hundred members, thus conflating the members of the Biocurious Meetup group with laboratory members.[42]

Attributing the Meetup "membership" numbers with the number of laboratory members was a common error in media reports, a mistake which went uncorrected by board members. The Singularity Hub article doubled down on this simple mistake by claiming newcomers to the lab can avail themselves of the expertise of

[42] There is a difference in the quality of participation here. Anyone with an internet connection can join a Meetup group as a "member." There is no monetary commitment or exchange of rights and responsibilities.

these five hundred plus members of the Biocurious community to help them as they get started in biotechnology. The article closes by saluting the pioneers of the Biocurious board for having the vision and organizational ability to make a "garage lab" a reality. Several images accompany the article, including the publicity photo taken after orientation, but one that stands out is a view of the laboratory, taken from the back of the lab that takes in the entire lab and classroom space, which looks bright, clean, and organized, yet folksy and garage like, in its white and blue color scheme. The framing of articles such as this one was a desired effect of the design principles operative at the laboratory.

So important were media visits to the board of Biocurious that there existed a protocol for controlling the circulation of photographs and video taken at Biocurious by the media. One Saturday morning in January 2012, I arrived to find a documentary film crew at Biocurious.

Since I had the opening shift, I was surprised and more than a little dismayed, as they were taking up space needed by the software Meetup group (this was shortly before their final departure) and a class that was to start at 10:00am. Following protocol, I sent an incident report to the given email address, after a little back and forth among board members over who exactly was in charge of allowing media to enter, I ultimately received the following clarification from a board member through the volunteer mailing list.

Figure 3.4: Biocurious Media Policy

Folks, it is the firm and unwavering policy of BioCurious that no film crew, photographer, videographer, documentarian, or working reporter is allowed in the lab unless accompanied by me or otherwise arranged by me. Or by the designated BioC media rep, in case that big, throbbing blood vessel in my forehead finally pops. Which it feels like it's about to.

I don't care if Wolf freakin' Blitzer shows up carrying Jim Watson piggyback in a time traveling Delorean with a huge clutch of triceratops eggs about to hatch.

Seriously.

So far, we have received favorable and intelligent media coverage. Part of this is the fact that we rock. The other part is that we work hard to convey the full story of BioC , and all the people involved, to the media. And we make sure BioC reps know how to handle inflammatory questions with grace. Admission with clearance is part of how we do this.

If someone rents a room to film interviews that don't show or involve the lab, media@ still needs to know about it. And clear it.

Also, we never invite people to film the content of a class or lab without doing an instructor the minimum courtesy of asking them in advance.

I appreciate the efforts of staff who were trying to hew to these policies. Please continue to take them seriously, and next time, know you are empowered to ask someone to leave.

The people involved will have a discussion about this and make sure this policy is clear enough to everyone in the future.

Thanks for your help,

If the media (and their audience) formed a special class of visitors not reflected in any accounting, another special class was constituted by researchers and those involved in biotechnology policy visiting the lab.[43] Researchers from think tanks and academic units involved in policy debates regularly visited the laboratory while I was a volunteer. That includes a number of FBI agents and amateur biologists brought to Walnut Creek in the summer of 2012 for the FBI/DIYbio conference. The conference is discussed in Chapter Six.

The Sponsor Wall and Corporate Classes

As with Walt Disney, the board of Biocurious cultivated an affinity to corporate America, actively seeking their participation in and support for Biocurious. Shortly after the Biocurious opened to the public, the board erected a prominent display of corporate sponsors in the reception area. Like the makerspace Techshop, it was envisioned that eventually, every discrete space and piece of equipment at Biocurious would have a corporate sponsor - down to individual microscopes and pipettes. In this way, the newest equipment could be sourced and maintained without relying on the skills or financial resources of the

[43] Today, corporate innovation workshops and "policy roundtables" are a public part of Biocurious' activities. Per the Biocurious website in 2015, "[Biocurious has] had representatives from the White House, Swedish Foreign Ministry, Science Ministry of the UK. All these people coming to learn about 'what does policy look like for biotechnology?'" See: http://biocurious.org/workshops/

membership. As well, raising money from corporate sponsors was a relatively easy way to make sure expenses were covered. And corporate gifts served as a hedge against both member demands and fluctuating membership levels. In addition to the sponsor wall, classes were quietly held for corporate customers whenever Biocurious' cash flow was faltering. Corporate classes were often led by one of Biocurious' volunteer instructors and rarely appeared on the public Biocurious calendar.[44] At least initially, corporate customers were largely drawn from nearby Singularity University, where deep connections to the board of Biocurious existed.

The first element of this strategy was the sponsor wall in the reception area. A handful of corporate sponsors donated money to Biocurious in exchange for the ability to hang a sign, initially in the reception area. The existence of the sponsor wall was used by the board to implement a policy banning members and volunteers from posting instructional posters and announcements on the walls without prior permission from the board. The walls of the lab were a space to be monetized, not

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[44] I learned about corporate classes by accident when talking to one of the volunteer class instructors who complained to me about the difficulty of organizing such large classes in a classroom where the benches sagged and the pipettes were uncalibrated. It was only then I discovered the corporate classes and their cost - four or five times more than public classes.

shared.

The design of Biocurious, then, was intended to instruct those who might visit in person or experience Biocurious through the media how to understand DIYbio within the history of Silicon Valley: not as a garage where potentially dangerous elements might mix uncontrollably, but as a new form of innovation lab, readily digestible for policy makers and potential corporate funders. Conversely, the sponsor wall enabled corporate sponsors to be included in the construction of "the next big thing."

Making (Volunteer) Behavior Visible

The principle of transparency did not only apply to laboratory furniture. It also applied to the behavior of volunteers, members, and visitors in the lab. Design principles were not only aesthetic choices designed to instruct, but they also connected the front stage image of Biocurious presented to visitors with the backstage work of the volunteers and members through a reporting system for holding volunteers and members accountable to behaviors and standards implied by the design principles.[45]

[45] The incident report is not unique to Biocurious. It is one management technique in a constellation of management techniques Thrift (2005,97) has identified as a body of knowledge intended to produce "what we might call 'souls' who better fit current and

To effect discipline within the laboratory, a special type of communication protocol, the incident report, was to be sent by any volunteer or board member who witnessed a policy violation to a special email address that the board (or only a subset of the board member, as the exact recipients remained a mystery) would be responsible for answering. The incident report was to be used to police adherence to both explicit and tacit policies. It was through the incident report that aesthetic and architectural principle were transformed into political practices. And the politics implied were not the democratic politics promised in press releases or in the statements of board members to the media, but rather a form of the "material politics" elucidated by Law and Mol (2008) and management techniques discussed by Thrift (2005,87).

The incident report was widely used at Biocurious. For example, the incident report was used by some board members to police the action of other board members, as this exchange involving three board members over the arrangement of chairs and tables in the classroom illustrates.

especially future systems of accumulation."

Figure 3.5: Furniture Disorder

I opened at noon, but had to spend the first hour just putting things in order:

1) All of the tables were shoved against one wall, like a Tetris game. The space was not set up for either a class, co-working, or a cleared area. One of the tables in a meeting room was cracked, and ended up being broken in half.

2) Chairs were stacked against the wall. The ones on the cart were shoved into the back room. Several pieces of equipment that had been on benches were stacked up in the back.

3) The folding tables were leaned against storage areas instead of put away.

4) I don't know if this happened at the end of Sat or Sun night, but I do know it's easier for a group of people to put the space back in order than it is for one person coming in, doing it by themself, and trying to juggle visitors (we had 3, one who commented on the mess).

Please step up and help me out here.

While the design principles were made explicit to me, albeit six months into my fieldwork, for some of the board members and all of the volunteers and members, the design principles came to be known only as they were bumped into through violations. The same was true of various policies the board attempted to implement at Biocurious. Little was explicitly communicated except in cases where a violation of the invisible rules of order had been committed. This was the case in the following email from a fellow board member responding to the original complaint above.

Figure 3.6: Response to Furniture Disorder

Sorry, the layout is my fault. After the GFP class people were coming in for the happy hour so I got all the tables and chairs moved out of the way. I left early and didn't tell anyone how to put things back afterwards. While we're on it, what should be the default config for the space now that we have all those nice new tables?

And the equipment that had been stacked up in the back is me too, didn't cross my mind to put things back after the GFP class, sorry! I'll make sure that's part of the post-class procedure.

Dunno about the broken meeting room table but that really sucks.

The aesthetic violation in this incident report was actually my fault and the board member being reprimanded was covering for my mistake. I was the volunteer on duty and was technically responsible for closing up and moving all the furniture into one of the acceptable configurations. But, like the board member, I left as happy hour was heading late into the night with the assurance from a member who had managed to obtain a key that the furniture would be returned to its original state. Ostensibly, I, as volunteer, was to order everyone out of the lab, return the lab to the default configuration, and lock up for the evening. However, as a practical matter, it proved impossible for volunteers to leave when members wanted to stay later than the official closing time of 10:00pm. The members, after all, were both paying to be there and operating on a schedule dictated by the whims of a microorganism. Hence, the volunteers were often in the position of having to trust that members would not put them in a bad position, and often that gamble backfired.

Policing board members was a minor and rather accidental use of the incident report; more commonly, incident reports were employed to discipline volunteers and reiterate a relevant design principle. Here, a volunteer, Jane, asks an innocuous question about the necessity of air fresheners in the bathrooms by replying to a list of "staff reminders."

Figure 3.7: Air Freshener Incident

Re: [bc staff] INCIDENT REPORT - **staff reminders** These air fresheners are a migraine trigger for me. Are they really necessary?

The complaint that air fresheners in the bathroom were a migraine trigger was not limited to Jane, the volunteer who sent this email. It was a sentiment widely shared amongst the volunteers, but Jane was the only one to bring up the possibility of removing them publicly. Importantly, Jane frames the problem in medical, not aesthetic, terms. While in some contexts “migraine trigger” would pass without consequence, because Biocurious was, at least from the volunteer's point of view, formed as a 501(c)3 nonprofit corporation and was emphatically open to the public, this phrase indexed a set of legal mandates required by the American with Disabilities Act, an act which Biocurious as a public entity must comply with. This polite email had teeth. The response was quick.

Figure 3.8: Reply to Air Freshener Incident

Dear Staff,

I would normally just include the following info in an Incident Report, but given that there are a lot of reminders here that are helpful for everyone in staffing.

The double doors between the lab and the back storage are NEVER to be locked. This morning, they were not only locked, but the bolt on each door was closed. This is a safety hazard. The double doors are to remain unlocked and unbolted at all times.

Trash is to be emptied every night. Trash (especially food waste) attracts bugs, and should *never* be left in trash cans overnight.

Check the coffee pot at the end of each day. Today there was coffee in the pot that I'd brewed on Monday. The coffee pot should be turned off, emptied and cleaned every day.

The front room should *not* have a table in the main entry way. All main aisles and walkways need to have a 3 foot passageway to comply with fire and safety regulations.

Extra chairs should not be propped up on the walls. they should be open and ready for sitting, OR on the chair holder in the main co-working area.

Air fresheners are located in each bathroom. Please do not relocate them.

Thanks y'all. I know it's a lot to remember, but keeping a consistent look and feel is important, and appreciated by the next staffer on deck.

Any questions - just ask! :)

As this response to a one-line question illustrates, the incident report and the policy violation it discussed offered a way for board members to obliquely respond to simple questions by contextualizing them as insignificant within a larger picture, which only the board could see. Note that the necessity of air fresheners is never discussed, only that they exist in the bathrooms where they are to remain. Here the board member refuses to acknowledge the necessity of air fresheners as a suitable topic for discussion between "staff" and board. The complaint is passed over without further comment. As well, volunteers are referred to as staff, a collective noun, and though the initial incident report to the board member is addressed to an individual, the response is to a collective. Further, the grievances the board member airs in this email are the collective sins of the "staffers." Staff are not individuals with individual preferences and sentiments; a mistake by one reflects upon all.

While no political deliberation over the issue of air fresheners was possible within the board member-volunteer relationship at Biocurious, Silicon Valley is a small town, and issues, such as the presence of air fresheners and the question of whether or not they trigger migraines, could be deliberated in other venues. Hence, it was no surprise when the email exchange above moved from the Biocurious volunteer email list to the mailing list of another Silicon Valley association. There, ongoing deliberations concluded that the volunteer in question has been well within the bounds of a volunteer's rights in asking for the air fresheners to be removed and that the board member has been dismissive of an important medical concern.[46]

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[46] If this kind of gossip seems inconsequential, one should remember Gluckman's (1963,113-114) injunction that gossip within a social group reenforces group cohesion and reminds everyone of their membership and participation, but gossip outside the group boundaries indicates a failure of group cohesion and the start of

This is all the more consequential in the laboratory, as the volunteer in question has a graduate degree in a laboratory science, while the board member has no scientific background. This particular email is also important, as it is one of the earliest referrals to Biocurious volunteers as staff - a subtle yet important distinction introduced at orientation which slowly became etched into volunteer life in the laboratory. Over time, this distinction would grow more important as incident reports came to have ramifying consequences on everyone at Biocurious.

Disciplining Jane's Sentiments

Many of the conflicts and tensions between the board and the members and volunteers are illustrated in the case of Jane. Jane lived close to Biocurious, a key geographical variable affecting participation at Biocurious, and had been active in Biocurious since the earliest days of the Meetup group. As such, Jane was one of the earliest supporters and advocates of Biocurious.

Jane designed the original Biocurious logo and was the volunteer whom I helped move the water bath into position prior to the lab opening. Most importantly, Jane had a graduate degree

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disintegration that, in the examples Gluckman favors, are often followed by charges of sorcery and witchcraft. A witch, of course, is to be expelled.

in a laboratory science and experience in the day-to-day business of running a laboratory. She also had a series of experiments planned. If the board members' media proclamations were to be believed, Jane was exactly the kind of volunteer Biocurious was hoping to attract.

It was odd then that Jane was not at the initial volunteer orientation. One day while I was at the desk, Jane brought some supplies for an upcoming event to the lab. I asked why she was not volunteering, and she explained that she wanted to volunteer in the laboratory, taking inventory, setting up lab equipment, running the autoclave, and the million other tasks that are necessary for a laboratory to work. Yet multiple board members were pushing her, despite her protestations, to staff at the front desk. For several reasons, Jane resisted staffing the desk. First was the need for someone to bring order to the growing disorder in the storage room. Second, Jane had occasional difficulties interacting with people. For both reasons, she wished to volunteer only in the lab, not at the desk. Her impasse with the board had kept her from doing either as she was not invited to volunteer orientation despite her ideal set of skills, dedication, and long history with Biocurious. Notably, her interactional difficulties were not problematic in the Meetup phase of Biocurious nor in the traditional academic laboratory where she was trained. But in the new “garage lab,” her interactional difficulties would prove troublesome.

Unsurprisingly, Jane was the earliest critic of the “garage lab.” And her criticism was doubly meaningful as it came from both the perspective of someone with long experience working in a laboratory and from long experience with Biocurious. Jane was the first to observe, and the only volunteer to discuss with me, the effect the designerly elements of Biocurious had on the ability to get biological work done in the lab. It was only after Jane mentioned the design of the space that I thought to ask a board member directly.

One afternoon at the front desk, I asked Jane why she thought the lab was so light on furniture and members, she replied that the board has a vision for Biocurious and they did not want just anything in the backroom. They wanted a clean "IKEA look,” not dingy old couches (that a member wanted to donate). The board worries that venture capitalists (in a repeat of the initial Thiel visit) might come in at any time and they wanted to present an organized, efficient look. Jane was critical of the contrast between the clean look desired of the Biocurious and the condition of the lab equipment, especially the benches. She showed me the lab benches that a board member made and pointed out where the tops were stained by reagents and delaminating. She observed that the benches sagged, making measuring impossible, were prone to contamination, and looked unprofessional to those trained in a traditional laboratory.[47] Jane noted that the design of Biocurious was the exact structural inversion of an academic lab. An academic lab has nice equipment in the laboratory and a motley collection of used furniture outside the lab. Biocurious had nice furniture outside the lab and a motley collection of laboratory equipment. Biocurious is not a working scientist's lab but a marketer's idea of a hip DIY space, she opined one afternoon. Jane also had concerns about safety in the lab, both in the manner of developing lab protocols for Biocurious and in the training and handling of chemicals and equipment.

Needless to say, her outspokenness about conditions at Biocurious led to several run-ins and disagreements with board members. Ultimately, Jane was removed from the space by board decision in December 2011. In the final sections of this chapter, I will detail Jane's disagreements with the board and discuss the incident that led to her removal from Biocurious.

[47] Jane was not the only member or volunteer to complain about the benches. The sagging complaint was so widespread that a board member and I spent an afternoon reinforcing them with side bracing. That helped some but still did not make them stable enough for measuring at the level of detail required for laboratory work.

Further Disagreements

Two email exchanges involving Jane during the last week of September and the first week of October 2011 illustrate how the "stupid is OK" mantra and the lack of interest in safety oversight was prevalent both at Biocurious and within the larger polity of DIYbio experimenters.

The first began on the global DIYbio mailing list, where many members and volunteers are active, as a response to a television producer looking to film a home laboratory setup. Given the intense media coverage of DIYbio and the sensational tone of media reports about DIYbio, as well as the sensational tone about the possibilities of DIYbio coming from many quarters, the television producer's interest was not surprising. The initial reaction was from a DIYbio experimenter who took umbrage to both the tone of the television producer's email and the intelligence of those who appear on reality television. A highly insulting term was used in referring to reality television participants and it was suggested that DIYbio was composed of people with high IQs and great scientific acumen, not the type of people who would appear on reality television. The email exchange grew heated as Jane suggested that derogatory name calling should be a part of DIYbio. The conversation took a further unfortunate term when a board member attempted a humorous intervention that went terribly wrong.

Between the hurled insults, Jane made a more subtle claim. She argued that there should be a sense of responsibility towards other among DIYbiologists, and that DIYbio might be a place where those marginalized in academic and industrial settings could find a place to do science. Jane's insistence that something other than the individual's liberty to tinker is at stake in conversations about DIYbio placed her in the minority. Her affirmation of the communitarian principle is doubly radical as she speaks as a woman with laboratory credentials - a rarity at Biocurious.[48] It is triply radical in that Jane's call is for a DIYbio accountable to something beyond the conditions of its own possibility. Jane argued for the other side of the American dynamic, the side emphasizing the responsibility of those who tinker not to damage each other.

This email exchange was quickly followed a few days later by a related exchange about the role, if any, the IRB process should play in the life of Biocurious. Following a long discussion of

[48] The political philosophy encapsulated by the "stupid is OK" mantra is one that assumes the individual's wants, needs and desires as the ultimate measure of action. This idea runs through much of Silicon Valley and is inscribed in the North American DIYbio Code of Ethics through the absence of any mention of accountability and responsibility.

the IRB, its role in corporate and university contexts, and whether or not it was legal for Biocurious to experiment on invertebrates, this exchange between Jane and a board member took place on the Biocurious Google Group.

Figure 3.9: An IRB for Biocurious?

It hadn't occurred to me before that BioCurious doesn't fall into just the lab animal ethics/care guidelines, since we are not a university or med school. I wonder what the minimum is to qualify for that?
Regarding lab animal regs, the short version is that you need IRB approval to work on vertebrates but not invertebrates. I think IRB = Internal Review Board, anyhow, it's a committee at the institution that reviews proposals to make sure they are ethical. (I think it would be awesome if we could have an IRB to approve any human studies ala Quantified Self so the results would be publishable; reputable journals require this.)

Jane's appeal here is to the norms of working biologists who publish in peer-reviewed journals. The question is about bringing the science at Biocurious into line with the norms of working biologists and placing Biocurious in the sphere of academic biology and holding open the possibility of publishing in scientific journals. This was a basic question about what Biocurious should be accountable towards and how an ethics of inquiry should, or should not be, addressed at Biocurious.

Figure 3.10: No Editorial Review of Member Projects

One thing to bear in mind is that BioCurious made a decision not to do any sort of editorial review of member projects. We're

> adhering to safety guidelines and working to ensure that all activities are safe according to the scope of materials and chemicals used. We are not enforcing a review process that makes any judgments whatsoever as to the worth, scientific merits, or other value of the work that people will do. This was a board level decision that we are not in the business of passing judgement on citizen science projects, nor do we want to go case by case reviewing the kinds of work that people want to do. The best way to handle this we felt, is by defining safety conditions within which everyone has the freedom to pursue what interests them.
>
> So if members come and do an incredibly (from our perspective) intellectually stupid, silly, or even, dare I say it offensive project (maybe some kind of bioart that makes a political statement), as long as it does not pose any issues from materials safety standpoint, we're not going to restrict that. Now, of course let's all use common sense. Disruptive activities that affect the well-being of the community or otherwise detract from the working environment, would fall under our membership agreement...

It is common practice for researchers in corporate laboratories, and increasingly in academic laboratories, to rely on external IRBs for research, hence removing the board of Biocurious from the equation. But Jane's call was for an IRB specific to Biocurious. Read this way, the argument for considering the IRB is a call to be accountable to a polity of experimenters rather than to individual motivation. In response, the board member posits a private agreement in the most severe form between the board and members as the sole criteria for judging the suitability of projects at Biocurious.

Figure 3.11: The Goals of Our Community

Not sure where you get the idea that IRBs judge which projects are worthy; if I recall correctly what my mentor at the University told me, they ensure projects are safe and ethical. Seems those are pretty much the goals of our community, right?

Jane explicitly reasserts the question of ethical experimentation and responsibility to a larger polity of scientists.[49] This was quickly resisted.

Figure 3.12: An Elvis Scultpture

...

If, as a paying member of BioCurious in good standing and abiding by the terms of the membership agreement, I want to come in and work on some idea purely for my own curiosity or gratification, and I am breaking no laws, nor engaging in any activity with safety implications, it is not actually our place to impose peer review on the independent work that individual engages in while using their own time and money... Nobody does peer review of your welding project at Tech Shop. If I want to do a giant sculpture of Elvis, its not going before a committee..even if it's the most hideous thing ever, catch my drift.

...

[49] An alternate reading of Jane's support for Merton's scientific norms (1996[1942]) might view her position in this debate as overly idealistic in light of the contemporary mode of scientific production. I have resisted this reading, however, because idealistic, utopian sentiments were common currency at Biocurious during the first year. The utopian sentiment does not mark this disagreement as extraordinary.

All of bioethics is kind of a minefield and I am wary of opening the door, however narrowly, to BioCurious invoking ethics judgments to veto someone's project. We do have policies in place to deal with dangerous activity. Beyond that, IRB's are mainly related to human subjects work and we're not engaged in that; given the set up of this lab and program, aside from quantified self type work where people are investigating themselves on and off BioCurious premises.

...

A welded Elvis sculpture is a wry commentary on popular culture, yet art is not isomorphic to science. Jane's response quickly followed.

Figure 3.13: Jane’s Response

...

In response to my reasonable queries about scientific **ethics**, one of our board members responded with screenfulls of BS claiming I had asked BioCurious to rate the scientific **merit** of people's ideas and what a terrible idea that was. That's completely not what I was arguing at all, making it a straw man argument. I was also disgusted that the people running this joint were displaying a lack of understanding of how science works. If I'm being asked to spend either $150/mo cash or >$400/mo labor for lab privileges at BioCurious but I can't do work that will be accepted in a journal, forget it... And I don't even need your facilities to do the work; I could do it in a corner of my studio apartment.

...

The technical portions of the experiment Jane mentions (which I have redacted) are banal enough to do in a studio apartment. In the apartment, functioning as a metaphoric garage, no assessment beyond the "individual choice" need be made. But, like Wittgenstein's ([1953]2009) point about private language, no meaning can adhere to the experiment either. This email exchange illustrated two radically different views of science. Nobody may review your welding project, but rarely do people claim to have discovered or created novel kinds of metal in a welding shop. In this sense, Jane's rejection of the "stupid is OK" mantra marked her as a source of trouble at Biocurious.

"In the Best Interest" of Biocurious

Throughout the fall, Jane had a number of additional disagreements, some public and others private, with various board members at Biocurious over how the "garage lab" should be operated. She was an unmoderated critic and a powerful voice for letting those with laboratory experience have a stronger hand in the governance of the laboratory.

In mid-December, there was an incident at the front desk involving Jane, which led to an incident report. Jane, myself, another volunteer (also an anthropologist), and a board member were the only people present. The incident could have been treated within the closed circle of board members and volunteers at Biocurious that day, but that was not to be the case.

The incident took place on my scheduled shift and unfolded over forty-five minutes in the late afternoon on a cold and overcast day. The details are unimportant, except to note that the event took place at the front desk in the reception where I was supposed to remain. I had left the front desk to help the board member move some equipment in the back room. Suffice to say that the interactional difficulties that Jane had expressed to me and had led her to seek a volunteer job in the lab and away from the desk, came to the surface that afternoon at Biocurious.

Rather than recounting the details of the incident, I will highlight the board's response. Like all events which led to incident reports, sitting down to write an incident report required making a choice, rooted in an ethical outlook, about what does and what does not constitute an incident. And following the report, it takes a tremendous amount of deliberation among those involved to decide what, if anything, to do next.

Following the event at the front desk, an incident report from the board member present was sent to the incident report email address a few minutes after Jane left Biocurious. I was carbon copied on the email as I was present and witness to the incident. Twenty minutes later, the board member with a background in human resources replied to the incident report via an email addressed to the full board, myself, and the volunteer coordinator.

Figure 3.14: Any Protected Characteristic

"Here's my two cents:

No one should be sitting behind the front desk if they are not the staffer on charge. Ever.

Staffers are responsible for maintaining professionalism while staffing, and while representing BioCurious.

Staffers who are not able to conduct themselves in an appropriate manner may be removed as staffers.

Members should conduct themselves in an appropriate manner, or be asked to leave the space. These items are not negotiable, and regardless of a person's gender, race, nationality, or any other protected characteristic."

Jane was neither an official volunteer nor a staffer, having never been invited to attend volunteer orientation or given safety training. Yet, the initial response applied the standards of a volunteer working a shift. The phrase that does the work in the above email is "protected characteristic." As was made clear at orientation, "doing good customer service" was the important characteristic for volunteer staff.

A few hours later, another board member weighed in with a differing opinion, one which emphasized Jane's interactional difficulties and contextualized them as something anyone can suffer given the right conditions.

Figure 3.15: Managing Jane's Interactions

Could she come up with a very regimented technique or protocol for managing her interactions at BioCurious? Would she be able to rely on this method to keep from getting to the point of an outburst?

...

The board can also draw up something for her outlining some options and explaining the bounds of acceptable behavior in the space. I think this is something she knows but is not able to do anything about when things get going in the wrong direction. So if there is some way to pre-empt this kind of behavior, it would be possible for her to participate. "

Over the next few days, a series of emails were sent back and forth among the board members. I was carbon copied on these emails, along with the volunteer coordinator. As well, I contributed an email verifying that the event had occurred. Along with the two differing opinions presented above, two of the six board members took neutral stances. The matter was ultimately decided when the two most absent board members deferred to the board member with a background in human resources to do what was "in the best interest" of Biocurious. Thus, it was decided to ban Jane from Biocurious and cut her off from an organization she helped to promote and support in its infancy.

Technically, Jane was banned from the laboratory, not Biocurious activities occurring outside that laboratory. But since there were no activities outside the laboratory, as a practical matter, the ban was total. Whatever the "best interest" of Biocurious was, it certainly allowed no space for criticism, alternative points of view, or unsuitable actions.

A week later, one board member who was particularly close to Jane and I met Jane for lunch in a downtown Sunnyvale restaurant to break the news of her banishment. Jane had specifically asked that I attend the meeting so that a witness would be present.[50] The meeting was tense. We ordered food but did not eat. Jane spoke about how she thought the board member had misrepresented Biocurious to her while asking her to volunteer. She expressed her concerns that Biocurious was not sensitive to the needs of people with disabilities. Biocurious does not need a wheelchair-accessible shower but Biocurious must try to make "reasonable accommodations" for people with disabilities. Jane advised the board member that consultants should come and speak to Biocurious.[51] Then Jane mentioned an email exchange with the board member in which he used the word "retarded" as an insult. Further, the carpet outgassing, the air freshener incident, and the board not allowing her to work in the lab or the backroom at Biocurious were all examples of not making "reasonable accommodations." We listened and I took notes.

After Jane finished, the board member broke it to Jane that she could not volunteer at Biocurious any longer. The board member spoke of "staff" and "staffing" and the behavior necessary to be a customer-facing volunteer. Jane responded by noting that

[50] I was both a constituent of and a commentator upon this experiment in volunteering.

[51] Later that day, a different board member told me that the consultants were Jane's legal counsel.

she had been volunteering (a word she chose deliberately) at Biocurious since 2010 for various events and activities and noted that Biocurious owes her two months of lab time for her labor. The board member countered and suggested that Biocurious actually owes her $200.00, the monetary value of two months laboratory access.[52]

I had to leave shortly after the board member broke the news to staff the front desk because my shift was about to start. When I arrived at Biocurious, the board member who sent the incident report was there. Unprompted, he told me that Jane had sued her last three employers. He said in the human resources business people like Jane are called "disability queens."

Then he recounts a story. A Thiel foundation member gave an invited talk at Biocurious and spoke widely on his life and work, including his diet. Jane found his dietary advice to be outrageous and, the board member explained, made a public scene by screaming a rude question at the speaker. Jane's outburst was a grave miscue, as the Thiel foundation member was an invited speaker and the Thiel foundation could give Biocurious "hundreds

[52] The move from volunteers to staff traces the move from two months lab time to $200. One is a gift of time, the other an economic transaction: two differing ways of relating to people resolved in favor of the economic transaction. This offer echoes the reasoning rejected by Jane in the email exchanges described in the previous section.

of thousands of dollars and make life easy here."

Conclusion

In Chapter Three, the strategic use of design principles at Biocurious to establish Biocurious as a particular kind of laboratory was examined. The design language allowed members, visitors, and media audiences of the lab to see the "garage lab" as evidence of a new industry being formed through synthetic biology, as previous industries had been formed through silicon chips, organic chemistry, and industrial manufacturing. Through the use of incident reports to tie concrete behavior at the lab to abstract design principles, a system of discipline was established which had the effect of transforming normally innocuous everyday items, such as air fresheners, into materials imbued with political consequences. The corporate structure, complete with a human resources specialist, and commitment to corporate sponsorship had the effect of undercutting the "community" aspects of the “garage lab.” The corporate structure also allowed the board to shape the space in subtle and not so subtle ways by forcing out volunteers and staff who did not fit the board's vision of Biocurious.

Chapter Four

Governing the Garage

Overview

Chapter Four extends the analysis of conflict at Biocurious that began in Chapter Three by examining several cases of conflict between members and the board of Biocurious. As the lab grew busier and more members began experimental programs, members with long laboratory experience came into direct conflict with board policy and design directives. The first case is occasioned by the serendipitous appearance of professional laboratory equipment brought to the lab by a group of members and volunteers. The equally sudden disappearance of the equipment led to a series of increasingly public and acrimonious conflicts at Biocurious over the purpose of the "garage lab" and the kind of activities that should be allowed within its walls. Following a discussion of the consequences of these conflicts, the chapter then proceeds with a discussion of the everyday business of volunteering at Biocurious. Next, the politics of classifying and the work of removing biowaste and trash at Biocurious is discussed at length. Finally, the chapter ends with a discussion of the particular difficulties in maintaining the laboratory equipment in Biocurious, where few were trained in the correct use of sensitive scientific instruments.

The Google Equipment

If the board was able to control volunteers' interactions with the interior space through the fall of 2011, by the spring of 2012, increased activity in the lab brought about a stiffer challenge to imposing the board's design principles. Following a holiday lull in activity around Biocurious, spring brought a handful of new members with existing projects to Biocurious. One member's project involved discovering a biomarker for a specific type of brain cancer - designed as part of his admissions package to a combined MD/PhD program and also pursued as a potential commercial venture. In the jargon, it was a proof of concept experiment. The reasons he related to me for selecting Biocurious over another lab for this project illustrate Biocurious' position in the wider ecology of Silicon Valley laboratory space. First, there was the matter of cost. Biocurious cost only 100 dollars per month (membership fees were discounted almost immediately after opening). Second, Biocurious was IP neutral, unlike a university or corporate lab.[53]

Aside from the reasons related by the member with professional ambitions mentioned above, another group of members who came to Biocurious that spring were interested amateurs who devoted themselves full-time to working in the lab. For the most part, these members were successful hardware or software entrepreneurs with the time and willpower to learn lab techniques from scratch based on the intuition that biotechnology would be "the next big thing." But the most powerful challenge to the board's design principles came from a group of laboratory professionals, some volunteers others members, who, like Jane, had years of experience working in academic and industrial laboratories.

The resistance to the board's designs on the lab took unexpected forms and often caught me by surprise, despite how entrenched I was (or I assumed I was) in the life of the

[53] For an individual researcher working on a speculative project, Biocurious was an attractive place to work despite the sagging bench and general disrepair among the equipment. If one only had to prove the validity of an idea to oneself, Biocurious worked well. However, a steady trickle of early stage startup companies came in for tours and without exception, decided against doing proof of concept work at Biocurious. Most opted instead for one of the local biotechnology incubators where lab space was on the order of $500-1,000 per month with a small percentage of IP taken. The advantage of access to professional equipment and ready-made networks of researchers and venture capitalists more than made up for the added expense.

laboratory. For example, early in February 2012, I arrived for my usual volunteer shift and found the back room overflowing with professional laboratory equipment. While I was surprised by the sudden appearance of the equipment in the back room, later in the week I was let in on the backstory of the equipment's arrival. Late in January that year, someone in the lab was notified that a Google-owned building in Mountain View was to be destroyed in a few days' time. The night prior to the demolition, a group from the lab removed two truckloads of laboratory equipment, including new benches and storage cabinets, from the building. The details of this expedition (such as whether or not permission was granted or whether or not the equipment was donated or looted) were murky. Among the equipment were slate-topped lab benches, unused chemical cabinets, and a fume hood. I was told that even more equipment was available, but was left behind due to the logistical issue of moving several tons of laboratory equipment on short notice. The only prior hint of the equipment raid was an email that circulated among the volunteers a few hours prior to the equipment removal.

Figure 4.1: Opportunity to Collect Cool Equipment

Hi everyone,

we have a great opportunity tonight to collect some cool equipment tonight 6:30pm near Shoreline, Mountain View. We'll need more hands, tools (Screwdrivers, Hammers, pry bars, carts, Metal shears, power tools etc etc).

I'll have a truck, and if you can lend a hand, respond to me personally and I'll get back to you with the details.

I'll sponsor some Pizza afterwards, too.

In contrast to the top-heavy decision making of the board, who would acquire a strategic director the day after the equipment appeared in the back room, the decision to bring several tons of laboratory equipment into the lab on the basis of an improvised trip to a building scheduled for demolition was a radical act - one aimed at both remaking the interior and political dynamics of the lab. It was an aggressive assertion of member and volunteer control over the space and a strong renunciation of the design principles governing the laboratory.

A few volunteers who were present on the night the Google equipment was picked up related the events of the evening in detail to me later that week. Google was demolishing a chemistry or wet lab of some sort (it was impossible to tell for sure) and had stored spare equipment in the buildings that were going to be demolished. Some members and volunteers were tipped off about the upcoming destruction and received access to the buildings from a Google employee who had visited Biocurious during a networking event. At the Google building, the removal crew told me they had to turn off their flashlights, duck down, and be quiet whenever security would drive by. They only had access for one night, and the entire operation involved three truckloads of material and took the efforts of about eight volunteers and members from the lab, almost all of whom lived nearby the lab and the Google building.

Figure 4.2: The Google Equipment

For three weeks, the equipment liberated (or looted?) from Google stayed in the backroom as plans were made by volunteers and members to move the equipment from the backroom into the lab. Two large square benches with flat slate tops (visible in Figure 4.2 above) to be installed in the center of the “garage lab” were singled out to me as the most desirable pieces from the equipment haul.[54]

The DIY benches had started to sway and sag even more as spring arrived, and the bench tops were further delaminating as they received heavier use. And it was widely believed among the members and volunteers that the homemade benches were contributing to the failure of experiments by virtue of their sagging, concave surfaces and the impossibility of cleaning them to laboratory standards. The slate bench, by contrast, was perfectly level and easy to clean. As one March visitor to the lab politely remarked about the homemade benches, using whiteboard material for the top was an "interesting choice of material for lab benches."

Early in March, during one of my volunteer shifts, two board members came to the lab and labeled the Google equipment in the back with blue tape indicating whether it should be kept or discarded. I toured the Google pile with them and asked their opinion of the entire incident. Their main concern was maintaining transparent storage in the lab and a consistent "look and feel" among the lab equipment. The homemade benches adhered

[54] Nobody at Biocurious expressed concern to me about the legal ramifications of this act. The mood around the lab was cheery and hopeful with the members and volunteers looking forward to reorganizing the lab to make it easier to work in the lab.

nicely to the blue and white Biocurious color scheme; the beige color of the Google equipment did not fit the Biocurious aesthetic. They were also quite irate that a group in the lab would take it upon themselves to fill up the backroom without asking permission. As soon as possible, the unlabeled equipment, including the slate-topped bench, would be moved to storage. The board members also complained about being forced to take time out of their schedule to label equipment. One of them remarked on the way out: "Let them open their own lab if they don't like it."

Figure 4.3: Labeled Google Equipment

The label in Figure 4.3 above reads "Drawers to Face Wall" in adherence to the principle of transparent storage. Sometime during the night of March 9th, 2012, the Google equipment disappeared from the backroom.[55] For the following week, the sudden appearance and equally sudden disappearance of the Google equipment was the constant talk of the lab. Conversations were struck up in hushed tones and emails circulated within trusted groups. The exact composition of the group which brought the equipment in remained a mystery, as did the composition of the group which removed it from the lab. The equipment vanished into the night as quickly as it had appeared.

Though nobody knew for certain where the equipment had gone, everybody seemed to have a theory. The Google equipment had been removed when two board members were out of town, leading many to consider the trip a false flag operation. Some thought that two people could haul the equipment off given the right equipment, while others opined that a minimum of six people would be necessary. Talk of conspiracies and conspirators abounded. Biocurious was suddenly a place of uncertain political currents, and I was afraid that my position in the lab might come to an end if I was not careful about whom I talk to and what I say. These were anxious days for me in the lab.

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[55] Biocurious closed at 10:00pm, but after hours activities in the lab were a constant feature of life at Biocurious. If one had a key, work could be done in peace after hours.

Drinking from the Labware

The days immediately following the removal of Google equipment were tense. My days at the lab were uncomfortable, as political factions were forming and pressure to take sides was mounting. The split between members and the board manifested in the sudden appearance and equally sudden disappearance of two tons of lab equipment was never mentioned in public conversation but dominated every private conversation. Tensions at Biocurious over how the space should be governed and who should have the political power to make decisions about working conditions in the lab were running high.[56]

At this time, several members and volunteers recounted to me stories of being “talked to” about their conduct in the backroom by a board member. The same issues Jane brought up the previous fall began to resurface in new forms that spring. Again, the question of whose expertise mattered here arose. Was this a laboratory? A startup company? A theme park? In the midst of this uncertainty, what counted as "acting suitably?” This was more

[56] The fact that the equipment came and left the backroom and never made it into the front stage of the laboratory or public conversations about the laboratory points to the work everyone at Biocurious performed to ensure visitors and media audiences were presented with a smooth vision of democratized science in action. We all performed consensus for outsiders.

than an academic question from my perspective. I was present for Jane's banishment and had the feeling that I could easily meet the same fate.[57] Yet, if I sided strongly with the board, I would risk cutting off access to members and volunteers. Something would have to give as my position at Biocurious was becoming untenable.

Shortly after the Google Equipment vanished from the backroom, the incident report, whose invocation could cloak any action in the aura of wrongdoing, appeared again as a public statement turned against a board member in an opportune moment. Notably, this incident report was generated by a member who purchased a lifetime membership during the Kickstarter campaign. Lifetime member is a unique status which, like class instructor, stands outside the recognized hierarchy of board member, member, and volunteer. In theory, a lifetime member could not be banished from the space. As a practical matter, they could be encouraged not to come to the lab.

Previously, I argued that Biocurious was transformed as it moved from a nomadic Meetup group to a stationary laboratory. This was certainly true of everyday life in the lab, but Biocurious continued to hold Meetups and functioned as a Meetup

[57] That I was capable of theorizing the reasons for Jane's banishment did little to relive the physical signs of anxiety I felt throughout my body when I was at the lab during this period.

group for some visitors to the lab. As I mentioned earlier, behaviors considered suitable at a Meetup group were not necessarily suitable in a laboratory.

The evening after the Google equipment was removed from the laboratory, a wine tasting Meetup was held at Biocurious. This was the kind of networking event Biocurious held many times as a Meetup group. People could come, taste some wine, and end the evening with a discussion of wine chemistry. In other words, networking with a veneer of chemistry. And, for the board, an opportunity to court potential corporate sponsors.

I was at the lab that evening when the following incident occurred, but left before the incident report was written. Importantly, this incident report was not sent to the special email address for incident reports, but rather to the email list delivered to all members and volunteers at Biocurious.

Figure 4.4: After Tonight's Wine Class

After tonights [*sic*] wine class, I noticed that there were beakers with wine in them.

When I talked to the responsible member, the member pointed out that they were washed before brought to the food area. Evidently not very well, as there was blue tape on at least one of them. I also learned that our visitors, who payed for this experience, had been drinking out of them. And that this was not the first choice of cup. I do not think the City of Sunnyvale has an express prohibition on drinking out of lab ware as this is very unusual behavior, but I do think we are on rather thin ice should a food inspector come to visit our premises during such an event. Because this is not very believable, I've taken some pictures:

Beakers mixed in with other cups.

Lots of beakers with wine

With blue tape from the lab on them, after washing, drinking wine and rinsing.

Further, there were two lab garbage bags with gloves in them. They are now in the autoclave bag.

This concludes todays report of safety violations.

Intentionally, the volunteer (a lifetime member working as a volunteer in this case) who filed this incident report referred to a board member as a "member" - the most egalitarian title at Biocurious. There is also the subtle mention of the real damage that could be caused by using labware as a drinking vessel: a potential problem that could end the Biocurious experiment. One of the cardinal rules of laboratory work is that the labware is for laboratory use only and not to be used, under any circumstances, for eating or drinking. This is particularly important in chemistry labs or, as was the case with Biocurious, when the labware in question is of uncertain provenance. The photo of the beakers below was attached to the incident report.

Figure 4.5: Wine Beakers

I responded to this incident as well for two reasons. First, using labware as kitchenware was an egregious safety violation and counter to all known laboratory protocols. Second, earlier in the evening, some of the wine bottles for the Science of Wine class had been dropped in the back by the new Strategic Director.[58] A member and I cleaned the wine spill, taking care to

[58] As was mentioned in the last chapter, the board of Biocurious had visions of finding a corporate sponsor for all equipment and classes. Hiring a strategic director, who may or may not have been paid, was part of this ongoing effort, as was the wine tasting class in question.

get down on the floor and pick up all the glass shards at some risk to ourselves. The wine spill was a potential hazard as it combined shards of glass with proximity to biowaste. The member was kind to help me, as I was the volunteer on duty and responsible for cleaning up accidents.

The new Strategic Director had carried the wine through the back door and transversed the lab. This was technically a breech of safety protocol, but this violation was common at Biocurious due to the parking layout. Coming through the back room, while heading from the parking lot to the classroom, the Strategic Director dropped a case of wine, breaking several bottles. The broken glass and red wine spilled on the floor had scattered among the equipment and shelves in the backroom. Though it was not at all clear whether the backroom constituted part of the laboratory or not, the autoclave and biowaste containers were there, and members routinely used the connected bathroom as an extra lab sink. Hence, we had to treat the broken bottles and spilled wine as biowaste, meaning that glass shards went in the sharps waste stream and the paper towels used to mop up the fluid were biowaste. As the member remarked to me while we were on hands and knees picking up glass shards, the mess in the backroom made it impossible for us to find and remove all of the glass. The member, who has been in preparation for medical school, was concerned about the possibility of someone getting a cut and developing an infection that would be difficult to diagnose.

In my email in response to this incident report, I wrote that I was often asked if DIYbio was dangerous. I continued that I had always responded that DIYbio was not dangerous, but now I would have to reconsider, as drinking out of working or previously used labware was a dangerous and stupid gamble. I made a direct provocation by arguing that the board member had put the visitor at risk without their knowledge. Hence, I resolved my political position as being with the members and volunteers. I felt relieved as I clicked the send button. As the original incident report was public, I sent my followup to the same public address. It would be difficult for the board to banish me in the way they banished Jane after this public exchange, though this remained a concern.

The two emails, the initial incident report and my follow on, provoked a lengthy response which is reproduced at length.

Figure 4.6: Board Member Response

Dear everyone,

Several things here.

1. I am "the member" referred to in the initial message.

2. There are several specific reasons why I made the decision to offer the use of beakers for the wine, which I will explain, at least in part because events of last night are not being reflected accurately.

3. I get that the decision was a big no-no. It won't be repeated.

4. Incident reports should go to "innercircle". They are not to be sent to "biocurious-helpers". There are specific reasons for that - not the least of which is more of a "heads up" to innercircle when things don't go correctly, vs. a "public reprimand" to everyone on the volunteer list. My skin is thick enough that I'm not bothered by the broader broadcast in this case, but for a volunteer/staffer with less experience, it could be very embarrassing to have your mistakes broadcast broadly when you're still learning the ropes and getting up to speed. Please make sure incident reports are sent to the correct address. They will be forwarded on to the broader staffing list where appropriate - usually after they're sanitized without the specific staffer/member's name(s).

Now for those of you who are interested in the background/detail of last night's issues, please read on. The rest of you can feel free to skip this part.....

Last night we did a "science of wine class". Each participant was asked to bring 4 wine glasses. Many didn't. Both the instructor and I brought additional sets of glasses, but a couple of last minute attendees, some last minute wine tasting additions to taste, and the people who forgot their glasses all added up to a shortage of the requisite number of glasses for each person. Glass was the preferred substance to drink from to help focus on the bouquet, etc. We have plastic and paper cups, and ceramic coffee cups by the fridge. And then I thought, "Hey, I could use glass beakers!".

I decided I'd drink from beakers myself rather than offer them to other class attendees, so I took beakers that were already designated as "clean" and rewashed them myself, including a handful extra "just in case". Some of them had tape on the outside with someone's name, a date, or nothing at all. I took the tape off all the glasses where it remained if they actually needed to be used.

One more attendee arrived just before we started. I had a one on one conversation with him about the glasses (He didn't bring any) and offered him the use of the plastic/ceramic cups, etc. Told him I was using beakers. He said he wanted to use them too. I asked if he was sure. Told him that I'd washed them myself, but I couldn't vouch for what else had been in them before today. He said he was fine with it.

After we got started (but before we started tasting) one attendee needed to leave early, giving us more glasses to work with. I offered some to the "beaker guy". He declined, and said he'd stay with what he had. I didn't insist.

After the tasting was over, we dumped out all the liquid and rinsed out all the glass ware in the bathroom sink, including beakers we'd used and beakers we didn't use. I then took the beakers back to the lab and re-washed them again. I also washed *a sink full* of glassware that had been left in the sink by someone else while I was at it. While I was washing glasses, I was asked why I'd allowed beakers to be used for the class, and chastised about my glass washing skills while I was cleaning up someone else's sink full of dirty glassware.

Now, I fully get that I screwed up. I won't do it again. However, if a staffer sees someone doing something dangerous, I'd expect them to pull me or any other member aside right away and mention it *right away* vs. after the class is over. That's what a community does - have each other's back. There was traffic in and out of the class area for the 2 hours from the time the class began to the time we actually started tasting. People will do things they shouldn't from time to time - our job is to help each other not screw up - and say something as soon as we notice it. I do it when I see someone about to head out of the lab with gloves on - and 99% of the time, it's because the person simply wasn't thinking. Same thing here. Mea culpa.

To say that I put a person at risk without any sort of warning is simply not right. I should have thought about it a bit more in depth, but he knew full well where the glass came from before he chose to drink out of it. He was offered alternatives and declined them.

If any of you'd like to speak with me about this further, please contact me directly vs. a continue a public discussion thread.

Thanks,

The board member is incorrect. It is impossible to be fully aware of the dangers of drinking from used labware, as one cannot be certain whether it contains trace amounts of chemicals that someone might react to in a dangerous, or even fatal, manner. Chemical residue left on glass labware from previous experiments is not visible to the naked eye nor can it be removed by dishwashing soap and hot water.

An individual may take the liberty to tinker with the classification of beakers, but a public entity, even a "garage lab" like Biocurious, takes such risks at its own peril. Undergirding the reaction to the board member's misuse of labware was a widespread desire by the members and volunteers at Biocurious to maintain Biocurious as a BSL-1 level laboratory and eventually create a BSL-2 level laboratory at Biocurious. Though BSL levels are a set of voluntary recommendations, they were taken seriously by most of the board members, members and volunteers at Biocurious. Jane's suggestion that an IRB process be implemented at Biocurious fell on deaf ears, but BSL recommendations carried jural force. There were hard limits on the individual's liberty to tinker, even at Biocurious.

Food per se was not a problem at Biocurious. The previous fall, there had been a sous vide cooking class in the classroom section of the laboratory that was held without entering the laboratory. And there was always food and drink available in the classroom.

The more onerous problem in maintaining the lab qua lab from spilling into adjacent spaces was the transparent design principle. In the interest of maintaining clean sightlines, the barrier to entering the lab at Biocurious was simply a piece of blue masking tape laid across the floor and a sign, attached to a a small easel purchased from the children's section of IKEA, warning that one was entering the laboratory and should not eat or drink in the lab. This was the same piece of blue tape I had watched being put down on my initial trip to Biocurious (and which, as of June 2015, was still separating the lab from the classroom).

Figure 4.7: The Blue Tape

The clean sightlines that defined Biocurious led to an ill-defined notion of lab space which contributed to this incident. There was also the issue of discipline at play here. Activities inside the lab, i.e. behind the blue tape were strongly defined rhetorically but weakly enforced physically. The “material politics” of discipline were strongly enforced when it came to policing volunteer behavior but weakly enforced when it came to disciplining access to the lab qua lab.

This incident, like the blue tape itself, illustrates a broader conflict over boundaries at Biocurious. In a professional laboratory, and for the lab professionals at Biocurious, there is no room for "not thinking" about certain activities. A good part of experimental technique, and something taught at all levels of laboratory education, is ensuring these habits of mind and hand are made automatic.[59] And a good part of laboratory design in academic and industrial laboratories is directed at insuring the proper habits of mind are materially enforced.

In this sense, contra the board's mantra that "stupid is OK," stupid is decidedly not OK for experienced lab workers.

[59] During the class I took in May 2011 at Genspace, these habits of mind and hand were drilled into those of us in class. As an example of the kind of education laboratory work entails, consider how often in the last minute you touched your face with your hand. In the lab, wearing gloves, this is disallowed. Focusing your attention on these small details requires an extensive education of the sentiments.

Stupid is dangerous and to act stupidly within the lab is to demonstrate that you should not be in the lab. Labware is expressly not kitchenware. That is, it belongs to the ritual space of the laboratory and not to the domestic sphere of eating and drinking. Work in the laboratory expressly denies the primacy of human sensation for the cold precision of mechanical measurement. It is never proper to focus on the bouquet of chemicals in the laboratory, and it is only outside the lab that bouquet has meaning. The violation during the wine tasting event is doubly important given the deliberations back and forth over the status of the laboratory.

Further, the "specific reasons" for sending incident reports to a select group was never fully explicated. In casually dismissing a serious mistake for an accidental oversight, the board member here is deeply playing with the status of the members and volunteers at Biocurious employed as working scientists. Media reports at this time focused heavily on the possible dangers of DIYbio and I was asked on a regular basis if what I was doing at Biocurious was dangerous. Multiple members who made their living in and around laboratories told me that their co-workers, and in some cases superiors, had openly questioned them about their involvement with Biocurious and the possible ramifications of an experimental accident. In some cases, they were asked to curtail their involvement in DIYbio.

Hanging over this incident was the question of what happens to a board member who violates such a critical safety rule? The corporate organization of Biocurious left no avenue for political reorganization, only the consumer's choice of whether or not to do business at Biocurious.

A few days after the initial incident report, the board member who served as safety officer sent a public email emphasizing the danger of drinking out of the labware and supporting the lifetime member's decision to send a notice to the "biocurious-helpers" list rather than to the "innercircle" address, despite the hazard of the more public email escaping from the closed circle of volunteers and staff members to wider circulation. The email signaled a split in the board, or more accurately, exposed an existing fissure. The safety officer would be the first of the original board members to resign.

Ultimately, this incident report publicly made the point that the board members were not working scientists and that Biocurious, despite the board's wishes, was a laboratory with a laboratory's potential danger, rather than a theme park. The incident report also served as a powerful argument that those with laboratory experience should play a larger role in governing the space.

TAPDO and the Limits of Design

The member and volunteer reaction to the labware incident was swift. Within a week, hushed meetings were taking place after hours in the meeting rooms, at the restaurant next door, and via email about how best to wrest control of Biocurious from the board. In many cases, these efforts were led by members experienced in the type of infighting necessary to wrest power from a faction within a corporate structure. The net effect of this unrest was to entrench those members and volunteers with experience in the corporate sector, especially those with experience as startup founders and leaders. With this development, the fulcrum of the disagreement with the board's governance of Biocurious was transformed. The disagreement was no longer over what kind of institution Biocurious should be, but rather which management techniques would prove more efficient in balancing the competing needs of corporate sponsors and members.

Late one evening in early March 2012, I sat in on an informal member meeting about moving one of the emerging community projects at Biocurious to a new lab space that one of the members had organized. The logistical necessities were lined up. A laboratory space was ready to be rented and could be put into use within a week if necessary. This potential lab space, existing in a liminal state of potential actualization, illustrates the ease with which equipment, experienced laboratory scientists, and space could be organized in a short period of time within Silicon Valley. The decision to stay or leave Biocurious would be made over criteria other than access to laboratory equipment. Another garage, with different rules, could be erected without difficulty.

While the new lab option was on the table, the path preferred by most attendees was to assume control of Biocurious and continue working at a lab with a recognized brand. And at this moment I realized that the discourse on Disneyland at volunteer orientation was as much practical as evocative. The design language and branding practices had done their work by ensuring that Biocurious was recognizable as something new, yet in continuity with previous institutions. The lack of desire to simply leave and open a new lab was a powerful demonstration of this point. The intense media coverage of Biocurious had worked to transform the lab into an entity that corporate funders and potential regulators understood. The only open question was how to smoothly break the board's control of the space without presenting to outside audiences - regulators, venture capitalists, policy researchers, politicians, and the wider public - a hint of disagreement or contention over the future of

Biocurious. Conflicts were to be contained inside the circle of DIYbio experimenters, and those outside were not to witness discord. Just who was to steer the ship was a contentious issue at this meeting, but the idea that the ship was to sail anywhere but a future in which biotech took the form of the computer industry was never in question.

The conversation during the meeting is paraphrased below. Kenneth, a monthly member, argued that they needed to be sure the lay of the land was understood prior to pushing the board to make changes. I pointed out that Biocurious has a corporate structure, not a hackerspace structure, and that we really had no ultimate recourse against the board except the option of exposing all the safety violations we were aware of. My argument was received with little comment. Everyone at this meeting of select members understood the corporate structure to be obvious and natural. Kenneth urged Matt, the lifetime member who sent the incident report described above, to take a broad view and to try to offer the board something in return for giving up control. He urged Matt to make it a win-win situation for the members and the board.

At this point, Kenneth recounted a sentimental story about how to approach and reason with visionary startup founders, i.e. with the founders of a startup whose vision is being enacted: in this case, the board member who authored the design principles. Kenneth had been the visionary in several companies and had in the past experienced difficulties getting a grounded perspective on his company. It is the natural state of the visionary founder, Kenneth argued, to live within and live out his vision despite difficulties. Kenneth also warned against emasculating any board member by making a hard play for control or simply leaving, saying that it is hard for a man with a vision to recover his swagger after being emasculated. This story was told with the pronoun "he," and "emasculated" was Kenneth's verb of choice. Kenneth also offered that he would not like coming to Biocurious if the safety controls were too strenuous. I countered that he generally worked under the guidance of experienced, laboratory-trained scientists. Finally, Kenneth advised that if Matt was going to open his own lab, he should act sooner rather than later.[60]

After more deliberation, a plan was hatched to force the board's hand by using all the leverage currently available to force changes around the lab. Failing that, the plan was to leave

[60] Despite the plea to act quickly, various groups would discuss breaking away from, or attempting a hostile takeover of, Biocurious for several years after this meeting. Usually these attempts were either tied to the precariousness of Biocurious' financial position or the inability of the board to act in accordance with member wishes. I recount the meeting above as it was, to my knowledge, the first such meeting.

Biocurious to open a new lab. The strategy would be to hold a laboratory reorganization meeting in mid-March, after which the members would proceed to reorganize Biocurious with or without board approval. A few days after the meeting, an email was sent out over the Biocurious Google group announcing a reorganization meeting. The meeting was held a few weeks after, and in its wake another email was sent around summarizing the meeting. The next step would be taking action to reorganize the lab.

Not much changed at Biocurious in the weeks and months following the lab reorganization meeting. The most important effect of this meeting was making public, and hence available for deliberation, the design principles and philosophy around which Biocurious was organized; for the first time, the design principles were in the open and available for public comment. About a month on, the square slate bench was moved into the lab, but the DIY benches (which I helped to firm up after the meeting) remained in place. Symbolic of the uncomfortable compromise reached after the reorganization meeting were the lower cabinet doors on the storage units moved into the lab. In an effort to render the cabinets transparent, a board member removed the lower doors. Unfortunately, the lower doors were structural and had to go back on to keep the cabinets from permanently leaning to the right. But, the cabinets were never the same after the doors were removed - the doors would no longer stay fully open or closed.

The seeds were sown during this time for later events - the departure of the Glowing Plant project from Biocurious and the opening of DIYbio labs in Berkeley and Oakland by former Biocurious members. These developments will be taken up in the epilogue.

Laboratory Maintenance: The Poetics of Biowaste and Min(d)ing the Junk Pile

Even during the tumultuous spring of 2012, day-to-day life in the lab had to go on. Classes had to be organized, tours given, and, most importantly, the biowaste had to be taken out. Taking out the trash had been a consistent problem since the September 2011 opening. Recalling the air freshener disagreement, the incident report sent to staff following the complaint included a reminder that all trash cans were to be emptied prior to closing every night.

Of all the design principles at Biocurious, designing a system to ensure the trash was taken out was the most difficult to put into practice. The day I discussed the design principles with the board member who devised them, my fieldnotes recorded that the main design problems were ensuring the trash is taken out and figuring out an automated entry system that was secure. Not coincidentally, taking out the trash and sitting at the front desk were the two most important tasks for volunteers.

Like the physical space at Biocurious, trash was divided into two classification: domestic trash and recyclables, and biowaste. While the nightly rounds of taking out the trash are onerous due to the large number of trash cans at Biocurious, it was routine. A more chronic problem developed when Biocurious initially opened. In the days and months following the lab opening, a large number of visitors came bearing gifts. Some brought equipment, some brought office supplies, others brought food, but almost all brought magazines, journals, and books to help build Biocurious' library. And as the months wore on, the journals and books began to pile up.

In early June 2012, a volunteer sent a distressed email to the Biocurious helpers mailing list asking about the disappearance of a large number of back issues of scientific journals from Biocurious. A few hours later another volunteer responded after discovering the journals in the trash. In a repeat of the Google Equipment episode, the bookshelf at Biocurious had been disappeared. A few days later a board member claimed responsibility and justified the action by claiming an unknown requiring the removal of all periodicals more than three months old existed at Biocurious. What followed was another conflict over Biocurious' status as a laboratory. The volunteers argued that the library was essential to the scientific program at Biocurious as most Biocurious members and volunteers lacked academic journal access, while the board member argued that the journals and other paper periodicals were an obsolete technology that cluttered the space. He responded to the volunteer concerns as follows.

Figure 4.8: The Free Reading Room

> Many academic and public libraries are disposing of their paper periodicals collections. Maybe you guys could contact them, offer to rescue the disappearing journals, and find some physical space to house them, then set it up as a free reading room. You can have what we've discarded as a starter set.
>
> ... I'd be happy to divert all the items people want to leave at BioC, but we don't have space for or inclination to take, and set it aside for you. It would certainly be easier to do that than to make myself available to screen donations. But you'd have to step up, and agree to haul it off, sight unseen. You could use these to start a free library, list it on Freecycle, or sell it on eBay and use the proceeds to pay for removing the giant, throbbing vein in my forehead that twitches every time people spend time complaining instead of doing something useful.

As was the case with the e-mail sent in response to Jane's question about air fresheners (Table 3.6), the board member does not allow a debate over what constitutes "useful" action. In the end, some books were donated, some old magazine issues were discarded, but the journals stayed. However, much of the useful equipment and manuals loaned to Biocurious by experienced lab workers were returned home, never to be seen at Biocurious again.

If the domestic trash allowed some elasticity in when and how it was disposed of, the biowaste did not. And it did not politely wait to make itself known. In February 2012 the biowaste announced itself as a smell emanating from the backroom. Something had to be done, but, what constituted "something useful" was problematic here as well.

Adding to the misery of spring 2012 was the question of what was and what was not to be considered biowaste. Theoretically, this question was answered in the Biocurious safety documentation, but the practicalities of classification were not simple theoretical matters. At question was not only which garbage was considered biowaste and which was not, but also how the biowaste was to be disposed of. The common and simple way to dispose of biowaste is to hire a service to collect it on a periodic basis. The way it was done at Biocurious was to run the biowaste through the autoclave and put the autoclaved biowaste in the domestic trash stream. And as with the Google Equipment, the labware, and the journal collection, the points at which the biowaste intersected with the domestic trash were rife with conflict.

The smelly crisis of spring 2012 was precipitated by the old military autoclave Biocurious was using, or rather not using, between the September 2011 opening and the spring 2012. One problem was that the old autoclave was intended to sterilize surgical instruments in a war zone and lacked the nuanced adjustments useful in a biological laboratory. Another problem was that prior to the spring 2012, so little work was performed in the lab that Biocurious was not forced to work up autoclave protocols to handle biowaste or the preparation of lab consumables. These tasks had been performed in an ad-hoc manner by class instructors and elsewhere by others with access to academic or industrial laboratories.

As a result, the spring 2012 uptick in lab activity caused a major problem for the lab in two ways. First, the foul smell caused by rotting *E. coli* bacteria was unpleasant at best and demanded that the backlog of biowaste be addressed. Second, the increased lab activity meant that petri dishes, agar, and other consumables had to made ready via the autoclave on a regular basis. Hence, the growing pile of biowaste and the mysterious autoclave spurred a rapid education into autoclaves.

On a Friday night in late January 2012, a handful of volunteers got the autoclave running by looking up the instructions in the book *At The Bench*, which one of the volunteers had loaned to Biocurious.[61] The action was spurred by the unfortunate fact that the refrigerator was full and there was no room for the petri dishes to be generated by an upcoming Saturday morning class. Hence, the old petri dishes in the refrigerator had to be autoclaved to make room for the new petri dishes.

The initial self-education into autoclaves was successful and throughout February, informal training sessions were organized among the volunteers. Step by step, the training sessions made measurable progress toward clearing the biowaste from the backroom and making the lab a little more resistant to contamination.

In late February, the board member in charge of safety decided to formalize the process and held a training class to certify some volunteers, myself included, to use the autoclave - there was no such certification required for members. On a Friday night, the first formal autoclave operation class was held, but unfortunately the autoclave died during the class. Right away, it was apparent the autoclave's regulator was defective; the autoclave overheated and the pressure grew too high too fast. Fortunately for the assembled volunteers, the autoclave did not

[61] This useful book would be repossessed by its owner following the journal incident detailed before.

explode. When it cooled enough to open, we discovered that the glass labware came through OK. This meant that for the time being, until the old autoclave could be repaired or another found, the biowaste situation would remain.

The autoclave setback spurred another source of conflict at Biocurious: What, exactly, should be considered biowaste? Specifically, what should be done with latex gloves and gels in the non-biohazard waste bins. This point of overlap between the domestic trash and the biowaste stream quickly became contentious. A volunteer with significant academic laboratory experience had been sorting the trash manually three times a week since January. Each night he worked a volunteer shift, he donned gloves and fished around in the trash cans picking out discarded gels, gloves, pipettes, and petri dishes that members and class attendees did not place in the biowaste bins.

Figure 4.9: The Guy Who Takes Out the Trash

Folks--

I'm the guy who takes out the trash three nights a week. In the white trash cans, which, to the best of my knowledge, aren't intended for biohazardous material, I have found pipette tips, gloves, serological pipettes, eppendorf tubes, empty petri dishes, and gels(*). These things probably shouldn't be going in normal trash cans-- if I'm wrong about this, I would really like to be corrected. Additionally, I've found gloves in both the front bathroom trash can and one of the trash cans in the back room. I have also seen two instances of people walking outside of the lab area wearing gloves; if we're worried about contamination, this doesn't strike me as a good idea.

The sensible thing to do, if we're talking about contamination, would be for me to treat a trash can with biohazardous waste in it as being entirely biohazardous and dump it into the biohazard bin. Our biohazard bin definitely can't accommodate this volume, so I've had to do the next best thing, and try to sort out the biohazardous stuff and dispose of it correctly. This is no fun and can take a while, especially after a class.

This email from the biowaste sorting volunteer sparked a public disagreement among the board members over whether Biocurious was being too strict about what counts as biowaste. One faction of the board was concerned that the biowaste stream would continue to increase if gloves were strictly defined as biowaste. Another faction wanted to strictly adhere to common biological laboratory guidelines in the interest of safety and public relations. Amid their disagreements, the volunteers continued to manually sort the trash, effecting a classification scheme of their own design.

In mid-April 2012, the old army autoclave at Biocurious finally died. A newer model was purchased and donated by a Biocurious member. Experiments continued and the biowaste backup was slowly worked through.[62] The new autoclave would help, but not entirely fix the trash problem.

Repair, Maintenance, and Laboratory Life

Despite a series of efforts (e.g. openPCR) towards purpose built equipment for DIYbio, DIYbio remains an enterprise built on obsolete professional lab equipment. Hence, a DIYbio lab is largely built out of the junked remains of previous laboratories. The image of material abandoned by an army in retreat is apt. Or, in the case of Biocurious, from the detritus of the laboratory build out precipitated by Proposition 71 (see also Benjamin 2013).

Even though the design language of the Biocurious lab called for no separation between the front and back of the lab, Biocurious maintained a junk pile of uncertain paternity in the backroom. Because the lab took in equipment of uncertain origin and function instead of using grant funding to purchase new equipment as an academic lab might, maintaining the donated

[62] It would be more than a year after this incident before Biocurious would hire a biowaste disposal service.

equipment and sourcing consumables was a constant struggle at Biocurious.

Unsurprisingly, there were always broken machines at Biocurious. While the presence of a junk pile is in many ways a given, what is not as obvious is the skill required to maintain and repair lab equipment. The difficulty in maintaining equipment was a key reason Biocurious was able to acquire equipment easily and inexpensively. As well, manufacturers often used proprietary consumables to lock users into their particular brand, so scrounging the proper consumables (pipette tips for example) was an important skill at Biocurious. Additionally, some laboratory equipment, such as the autoclave, was particularly sensitive to improper use and needed to be cleaned correctly after misuse. In sum, it was vital that someone at the lab be able to repair the equipment.[63]

In late April 2012, I gave a tour of Biocurious to Tom, a retired electrical engineer. When I asked what brought him to Biocurious, Tom immediately told me that he hoped to experience the same excitement at Biocurious that accompanied the early days

[63] During my time at Biocurious, the lab was fortunate to have a pair of electrical engineer's tenure at the lab overlap. Without their circuit wrangling skills, getting any biological work done at Biocurious would have been even more difficult.

of his career in the integrated circuit industry.[64] He explained to me how the situation in synthetic biology was comparable to the development of integrated circuits four decades ago. He said that all circuits were now designed using computer programs and built with robots so that the designer never sees the circuit and he expected it would be that way in biology as well.

Tom explained that he did not want to work in the lab at Biocurious. Rather, he wanted to automate laboratory processes. The tour I gave to him was the best tour I gave at Biocurious. Despite all the conflict in the lab (this tour came shortly after the labware incident), I sold Biocurious as hard as I could to Tom because Biocurious needed someone to come in and sift through equipment, repairing what could be repaired, automating what could be automated, and bringing some sense of stability to the autoclave situation. Through late spring and summer of 2012, Tom set to work. After a new autoclave was found (a member bought and donated an autoclave found on Craigslist), Tom took it apart, cleaned it, and made sure it was in working order before anyone was allowed to use it. The list of equipment he worked on was

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[64] This was a common sentiment among members and volunteers at Biocurious. The sense that something new is happening and that you are in the middle of ushering in great change is intoxicating. Several members confided to me that part of the appeal of DIYbio was a chance to feel that emotion and excitement once again.

extensive. And the repair and maintenance skills he brought to the lab was appreciated by almost everyone.

A Comedy of Agars

By August 2012, Tom was less enthusiastic. One late summer afternoon, he gave me a litany of complaints about the condition of the equipment at Biocurious and the difficulty of keeping things in working order. Tom's disenchantment was driven in large part by the presence of a group of Thiel fellows in the lab. In the spirit of "making things easier" around Biocurious, the board, without notifying the members or volunteers, had authorized free memberships to the 2012 class of Thiel fellows. That summer, they worked in the lab like vampires, appearing late in the night to work and disappearing before morning. They apparently had keys to the lab, unlike most regular members, and therefore the freedom to come and go as they wished. Their presence was verified through the existence of storage boxes in the backroom that housed their supplies. Of course, their storage boxes were as transparent as the others, so a quick scan of their supplies let everyone know what they were working towards. If the material traces of their reagents and consumables left no doubt about their experimental program, the broken equipment and biowaste left in their wake left no doubt as to their skill level.

Their favorite target was the new autoclave. One incident, visible in the material traces it left behind, will illustrate the difficulties that the 2012 class of Thiel Fellows caused Tom. While working into the night, a Thiel fellow (or two) let a container of agar boil over in the new autoclave. The agar worked its way into the autoclave’s steam tubes, taking the autoclave out of action until it could be properly cleaned. But this was not the end of the night's agar problems. A trail of agar led from the autoclave to a hot plate where the fellow had tried again to reach the proper melting point without boiling over. Again the fellow failed. From the hot plate, the trail led to the microwave, where agar had exploded inside the oven. The fellow did not pause to clean up any of these spills and had simply moved from one piece of equipment to another in the quest to prepare the agar without boiling it over. After surveying the scene and reconstructing the night's actions, Tom spent a long Sunday morning and afternoon at the lab cleaning the agar out of the hot plate controls by disassembling the hot plate and hand cleaning the circuit connections. He also cleaned the interior of the microwave. Then he had to take the autoclave apart, for the third time that month, to clean agar out of the small tubes running from the water container to the pressure chamber. Until the Thiel fellows left for more permanent lab space in September 2012, Tom repeated his cleanup efforts nearly every week. Needless to say, Tom eventually left Biocurious, burned out by cleaning up after members, fellows, and class attendees.

Miscellaneous Volunteer Duties: Keeping Keys and Handling Bodily Fluids

Volunteer duties included scanning the lab periodically, which meant walking around the lab and to see what people were doing, and closing up at night, which meant asking lab members to leave, even when they wanted to stay. Both of these duties included a measure of policing. Volunteers were to be on the look out for suspicious behavior.

Other duties included mopping the floors, cleaning the bathrooms, stocking supplies, and receiving packages sent to the lab. The volunteers, myself included, often wanted to leave at 10pm when the lab closed. I stayed later at times, but at the end of a volunteer shift, I was often exhausted.[65] The power to expel

[65] Though by summer 2012, some members figured out how to get keys to the lab and this changed the power dynamics dramatically. Now volunteers had to trust members who wanted to stay late not to do

members from the lab promptly at 10pm was often used by volunteers as a measure of resistance towards members who demanded too much from the volunteers (such as excess cleaning), or were rude to volunteers.

Members on occasion had bodily fluids, usually (but not always) saliva from relatives to be used for DNA analysis, sent to the lab for experimental purposes, which caused some consternation among the volunteers. One can never be sure that an amateur knows how to ship saliva without spilling. Though shipments of bodily fluids were a rarity, an everyday concern was whether packages containing laboratory reagents were received and stored correctly. Some reagents could be stored at room temperature, but it was common to receive reagents that either needed refrigeration or freezing, and were highly sensitive to temperature changes. Reagents were normally sent via overnight delivery and were prepared by the shipper in a foam box with a strategically placed ice pack. If, for some reason, the package could not be received in time, the reagent was likely to change temperature and the effectiveness of the reagent might be reduced or the reagent could be ruined. Within the lab, a further danger to the reagent was the household refrigerator used to store reagents. Reagents stored close to the door were especially

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something that would trigger an incident report.

subject to temperature variation from people holding open the refrigerator door while digging through the packages for their reagents. In cases like this, figuring out at what point the reagent went bad was impossible.

Conclusion

This chapter took up several conflicts at Biocurious over the constitution of the laboratory. Was the laboratory to be seen as a scientific theme park suitable for demonstrations (spectacles) of the latest scientific breakthroughs to visitors and media audiences, or was the lab to be a space recognizable by professional laboratory scientists as a place to work? These conflicts were only partially resolved. As it was hinted previously, the contentious issues which appeared intractable at Biocurious would later form the rationale for a series of new DIYbio laboratories. This process is taken up in the final chapter and in Appendix Two.

The next chapter examines the experimental program at Biocurious, asking who may lead and witness experiments in this new venue. In the form of a "community project," we find the same problems of expertise and design that was worked through on a smaller scale modulated from the institutional level of Biocurious to the level of a handful of experimenters in the laboratory.

Chapter Five

The Bioluminescent Community Project

Overview

This chapter describes the Bioluminescence Community Project. The Bioluminescence Community Project began as part of a larger effort by the board to spur membership and activity in the "garage lab." The following section detours to narrate a brief history of research into bioluminescence, emphasizing the mystery of bioluminescence and difficulties scientists have faced in harnessing bioluminescence. The remaining sections discuss the origin and mechanics of the Bioluminescence Community Project.

Further sections describe how the composition of the project came to change from the first proposal of a humble household lamp into a commercially viable project that would present Biocurious as the kind of Silicon Valley "garage lab" where new industries are created. Finally, the last section describes how the members of the project organized themselves to carry out an experiment and examines the process of establishing a new form of experimental witness at Biocurious.

The Bioluminescence Community Project Comes About

This chapter takes up the history of the Bioluminescence Community Project at Biocurious. As with my participation in Biocurious, I was present at the project's initial meeting and was both constituent of and witness to the course of the project. The same processes at work in Biocurious were at work here on a smaller scale: the question of how to design an experimental program for amateurs, the deliberations over how to govern the project and for whom to govern, and the paradox of democratization.

The Bioluminescence Community Project emerged out of a contest to find projects that would encourage visitors to join as members and begin working in the "garage lab." Activity in the lab was slower than anticipated through fall 2011, so it was decided in November 2011 to survey the membership and create two community projects. These projects were envisioned as establishing a smooth path from visitor to dues-paying laboratory members. In this way, the community projects were expressly pedagogical in design. The first aim was to attract members of the public by instructing them in what was possible at

Biocurious, and the second aim was to train potential members in the rudiments of lab work so they could go on to pursue independent projects.

In November 2011, a call was put out via email for community project nominations. Becoming a community project granted the project a specific meeting time and laboratory space. It also enabled people to come twice without joining, thus allowing the constant circulation of prospective members into the lab. It was entirely unclear, though, whether a popular vote was enough to launch a project, or if there were other criteria that would be taken into account.

Following a round of nominations in November, by December 2011 twenty candidate projects had been winnowed down to two winners - one aimed at creating a bioluminescent lamp and another at creating a 3D bioprinter to print living tissues and cells. Both of these projects were presented as straightforward engineering projects, in line with broader presentations of Biocurious as a new type of "garage lab" with new engineering projects. While the bioprinter project did follow a straight engineering path and met with almost immediate success in enrolling members and attracting media attention, the bioluminescence project would run into thornier problems related to the ambiguity of experimentation.

Figure 5.1: We Need Your Vote

WE NEED YOUR VOTE

Click here to help decide what group project BioCurious will take on first. The project(s) we choose will be open to ALL members.

METHODS

We came to this list through several in-person and email group discussions.* These were open to the entire community. The short list has a good mix of synthetic biology, molecular biology, citizen science, and biomedical engineering projects.

From here, we'll further shorten the list and, if necessary, take a final, deciding vote.

Be a part of foundational BioCurious experiments (with friends!). VOTE NOW.

The losing projects ran the gamut from classically academic projects, such as identifying unknown proteins and investigating dandelion speciation, to food safety projects with a consumer oriented focus, such as identifying the ingredients in coffee. [66] Mixed in were a good number of engineering projects, both hardware and lab-based. As part of the voting process, each project had to prepare a campaign statement. Biocurious members, volunteers, and Biocurious mailing list subscribers were eligible to vote in the contest. After voting, the board selected the two projects they thought best represented Biocurious. Below is the campaign synopsis for the bioluminescence project.

[66] I voted for the dandelion speciation project and later helped to start it as a citizen science project at Biocurious. The project lasted three short months.

Figure 5.2: Bioluminescence Night Lamp

Bioluminescence nightlamp with bacteria

(Survey says: 14 participants, 3 leaders)

Either work with Vibrio fischeri (can obtain from, e.g., ATCC), probably insert some genes to realize a biological clock so they make light in the evening,

or work with E Coli and insert luciferase gene, and some fancy control mechanism.

Probably realizing different wavelenghts of light if possible.

The hardest part in this project might be to keep your engineered bacteria alive. To get around this problem, we could work with cyanobacteria or algae instead. Essentially, build a little biosphere globe where the engineered algae are a stable member of the community

Luciferase would be preferred, but may impose too much energy cost on the cell. If we're talking "nightlamp", I think it would be acceptable to use a small UV LED to light up a fluorescent protein instead - easier to engineer, and less expensive for the organism.

As the campaign statement makes clear, the bioluminescence project would require genetically modifying a common lab strain of the *E. coli* bacteria developed at Stanford several decades ago with a luciferase system that would cause it to be bioluminescent in darkness. Hinted at here is the level of difficulty entailed in engineering bacterial plasmids. Just in case the bio-engineering proves to difficult, the project's leaders had a simpler solution in reserve. This speaks to the level of showmanship (Boon 2000) present at all levels of the "garage lab." The lab was for show and the community projects were (at least partially) as well.

Like all engineering projects, the bioluminescence group sprang from a practical problem. The initiator of the project (a volunteer at Biocurious) was an artist then living in San Francisco. Due to the cost of housing and the lack of a strong market for working artists, he was living illegally in an art studio where he rented space. He wanted a form of light that would not require wires or other signs of human habitation so he could read after dark without attracting attention. As will be discussed below, his idea for a bioluminescent lamp was, in turn, inspired by a designer working at Philips, the Dutch electronics company.

A Brief History of Bioluminescence

Before describing the course of the project, a word about bioluminescence is in order. Though Biocurious considered itself "the next big thing" in Silicon Valley, the bioluminescence project took its cue from an old mystery. The unique characteristic of bioluminescence, cold light, was first recorded by Aristotle. But it was not until the operation of cold light was explained by Robert Boyle, who discovered that air was required for the production of cold light, that bioluminescence became an object for laboratory inquiry. Though Boyle discovered the mechanism at work in bioluminescence, the workings of that mechanism has stubbornly resisted human attempts to tame it. A literature review I conducted with another member of the community project turned up a renewed history of academic work on bioluminescence starting in the early 20th century.[67] This renewed interest in taming bioluminescence dates to the emergence of biology as an engineering discipline in early 20th century and continues unabated.[68]

A similar phenomenon, fluorescence, has proven more amenable to the harness. Osamu Shimomura won a Nobel Prize for isolating GFP (Green Fluorescent Protein), which is now a widely used as a biomarker and biosensor. Fluorescence works by using an outside light source to invoke a response from the fluorescent protein. Fluorescence is understood well enough that transforming a bacterial plasmid with GFP served as a common introduction to

[67] One of my more important roles at Biocurious was providing academic papers. Lack of access to the current scientific literature was a major stumbling block for some lines of inquiry, particularly in researching methodological tricks of the trade.

[68] The engineering impulse in biology is most associated with the work of Jacques Loeb. But interest in taming bioluminescence can be traced largely to the work of Edmund Newton Harvey. For a general history of bioluminescence see Harvey (1920). The literature review was of no consequence to the conduct of the project. We only dug into the literature when necessary. We did not locate an open question in the literature and attempt to give an answer.

synthetic biology principles and techniques for newcomers to Biocurious. The demonstration has been a staple of the corporate and innovation workshops held at Biocurious.

Design Probes, Glowing Yogurt, and E.glowli

As mentioned in the last section, the bioluminescence project found a muse in a speculative design project sponsored by the Dutch company Philips as part of their future-oriented Microbial Home Project. The Microbial Home design probe had received wide media coverage in both the DIY and design blogospheres in late 2011 and was often discussed in the media, not in terms of a speculative design oriented towards a hypothetical future, but rather in the present tense of an imminent product launch. But imminent it was not.

If the Microbial Home was one source of inspiration, another source of inspiration was the possibility of creating glowing yogurt using bioluminescence. The speculative designer Tuur van Balen's project Hacking Yogurt at the Next Nature Powershow 2011 in Amsterdam was also circulating in the blogosphere and on the DIYbio mailing list. Next Nature Powershow is a self-described "intellectual spectacle," and van Balen's project was such a spectacle as he demonstrated how to hack yogurt with various genetic materials to make it glow or alternatively deliver pharmaceuticals. I use demonstrate here ironically, as his presentation was entirely fictional and speculative. However, the speculative aspect was soon overlooked as the YouTube video of his presentation began to circulate without the context of "intellectual spectacle."

Yet another source of inspiration were several iGem (Internationally Genetically Engineered Machines) projects using bioluminescence to speculate on future biosensors and home lighting. In particular, the E.glowli project did some calculations, indicating that lighting from bioluminescence might be feasible in terms of energetic requirements, which was particularly important for the community project. But here again, the E.glowli project was speculative design probe, not a concrete commodity.

The existence of so many diverse points of design inspiration for the bioluminescence project points to the influence of speculative design on bioengineering.[69] Design probes and science fiction(s) formed a potent brew which often overrode the concrete reality of our scientific limitations and

[69] I would point again to the lack of interest in our literature review of bioluminescent phenomena. The history of science carried little interest at Biocurious. On the other hand, potential futures, as exemplified by speculative design, were compelling.

led us to believe we were capable of much more than we could deliver. Yet design probes and science fiction(s) like microbial light also drove us to imagine possible futures we would not have otherwise imagined, and they helped shape the course of the project by employing novel means to further the project. For example, the possibility of obtaining the E.glowli biobricks would lead us to find a back channel into a Stanford laboratory in order to obtain a set of iGem parts.

Narrowing the Pool of Participants

The initial email from Biocurious, which was viewable by the wider public beyond local Biocurious members and volunteers, read that voting was open to the community. In the following email from the bioluminescence project, also public, the project organizers say nothing to contradict this spirit of openness and transparency.

Figure 5.3: Narrowing the Participant Pool

1/5/2012

Do you want to join a project that is fun, exciting and glows in the dark?

Join our BioCurious Community project to make a bioluminescent nightlamp, experiment with bioluminescent cultures and make our own glowing organisms!

The first meeting will be next Monday, January 16th, 7.30 pm

@ BioCurious.

There will be a small presentation, brainstorming session, and luminescence in action!

For more information check out the project Wiki

I think you need to apply for access to the Wiki but usually it doesn't take much time.

Looking Forward to see you on Monday then,

However, the initial email was followed by the following message from Thomas, an annual member, approximately twelve hours after the initial email. The second email began to set limits on the terms of participation in the "community project."

Figure 5.4: No Lurkers, Please

Just a clarification regarding the wiki page: We're trying to keep the BioCuriousMembers wiki restricted to members (obviously), plus non-members who are actively working on the community projects. So if you would like access to the wiki, please let us know what your background is, and how you feel you can contribute - no lurkers, please.

We will also set up a Google mailing group for day-to-day discussion. If you'd just like to listen in on what's happening with the project, that one will be open to anyone.

The initial hint of exclusion is contained in the words "actively working." It was not explained further why limiting access to the wiki was necessary, particularly why a "community project" at a DIYbio lab with a self-described mission to "democratize science" might need a firewall between their work and the public. Yet, here is the classic Janus-faced division (Latour 1987) between the everyday work of science and the communication of that work being harnessed to exclusionary ends. This was the initial drawing of boundaries around the community of experimenters on the bioluminescence project. More would follow.

The division to keep in mind is between those "actively working" and those "lurking."[70] This would turn out to be an important distinction as the majority of those who would be "actively working" on the project lived within a 15-minute drive from Biocurious and had time to attend to the project and enough money to purchase supplies on a regular basis.[71]

[70] Much of the email discourse at Biocurious revolved around a distinction between those who were "making" Biocurious and those who were "taking" from Biocurious, or as table 4.4 illustrates, not being "useful." This distinction mirrors a wider American discourse around the role of "makers" and "takers" which is particularly prevalent in Silicon Valley.

[71] Per Shapin (1984), Boyle's lab, in keeping with the social conventions of his day, was egalitarian across the narrow strata of gentlemen in his social class; but this egalitarian strain did not apply to those outside the class of gentlemen that Boyle hailed from and addressed in his work.

Notably, apart from the sentimental aspects of social class, what was required for the experimental life was time for leisure.

The Initial Meetings

The bioluminescence project met weekly on Monday nights beginning in mid January 2012. The meetings followed a standard form. At the start of the meeting, introductions and personal updates were given. Following that, everyone was brought up to date on the progress of the project. Given that prospective members arrived nearly every week, introductions and personal updates lasted nearly an hour every week. This was before my substantial work on the project could begin. The sheer amount of communication required to keep everyone on the same page was at times overwhelming and certainly contributed to the slow progress over the life of the project. In what follows, I will discuss the initial bioluminescence meetings and our first experiment.

The First Meeting. On a Monday evening in the middle of January 2012, we held our first meeting. The mood was light and hopeful, not unlike the mood at the initial volunteer orientation. After a round of introductions among the roughly dozen people present, Alex, the initiator of the project explained that his long-term goals for the project were to develop a series of educational initiatives at Biocurious that would include a series of classes, lectures, and workshops for both adults and children.[72] Ideally, these classes would revolve around expressing bioluminescence through yeast. These initiatives would be created at Biocurious but made freely available to those outside Biocurious. But before this can happen, he announced, "we have to get ourselves educated." A Biocurious member added, "It would be great for us if we could teach the kids . . . each of us because then we would know for sure that we actually knew it." Like the initial volunteer orientation at Biocurious, the initial bioluminescence project began in a utopian mode.

Following Alex's exposition of his goals for the project, the question of organizing ourselves for the work ahead was addressed. It was decided, with some hesitation, to use the internal Biocurious wiki and a Google group for the project. Thomas, the annual member who sent the initial project email, noted of the internal wiki, "we are trying to keep access to the

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[72] But it was always difficult to tell exactly who was in the bioluminescence meetings as people came late and left early and visitors at Biocurious often commingled with regular bioluminescence members.

wiki under control," though the bounds of the "we" was never explicated. So we proceeded with an internal wiki for active project members and a Google group for public announcements. For organizing the work, we decided to meet for a few hours on Monday night during the official meeting time to discuss the previous week's progress and chart the course of future work. The physical work would be broken into smaller teams to work on elements of the project in parallel. This is a standard way of coordinating product development teams in the software industry and was familiar to the cohort of members and volunteers who have worked in startup companies or corporate engineering teams.

Next, we watched a few videos produced by iGem teams at MIT. The mood was light and the videos were inspirational. As at volunteer orientation, I was caught by the optimism. Following the video, we made a decision to use the E. glowli team's work as a jumping off point and to obtain parts from the iGem parts registry (commonly called "biobricks") database at MIT. Though earlier in the meeting our hope was to work in yeast, the iGem parts were from an *E. coli* plasmid so we quickly set aside our yeast plans to focus on bacterial plasmids. Our revised hope was to start with something pre-existing and modify it with one of the recently developed software packages written to design the DNA within bacterial plasmids.

The iGem competition started at MIT in 2003 as a way to raise the profile of, and encourage participation in, synthetic biology. Teams competing in the annual iGem jamboree were required to send the genetic "parts" they created in the course of their project to a depository at MIT, called the "registry," where they would be made available to the next year's teams. In this way, a standard library of reusable components as in software development would be built up. During the initial project meeting, we interpreted iGem's aspirations literally, assuming that a library of interchangeable parts existed and had been vetted.

During this initial meeting, all decisions were made by informal consensus. However, left open amidst the organizing meta-talk was the question of how we were to "get ourselves educated." At one point during the meeting, Kathy, a Biocurious member, noted that she had previously worked at the *E. coli* reference center. "Alright, we have a teacher" was the response from Kenneth, a member with startup experience. And with Kathy's expertise with *E. coli* as a guide, the decision to set yeast aside and pursue an *E. coli* solution was formalized.

The Second Meeting. In the week between the first and second meetings, we decided, in a decision organized via email, to purchase a kit from the Modern Bio company to effect the transformation of luciferase into *E. coli*. This would be part of our educational efforts. A sticking point was finding someone affiliated with an educational institution who could order the kit for us. This search for someone inside an institution who could do us a favor would be a constant theme over the next few months. For example, whenever academic literature was needed, I served as someone inside an educational institution by using my University library access to find articles, which I then circulated to the group. In the search for a suitable cover for our Modern Bio kit order, a project member offered to take risk by asking their child's chemistry teacher to order the kit through their institutional account, but eventually it came to light that someone teaching classes at Biocurious had the proper credentials. Later in the week, we asked for help, and the kit was duly ordered.

The second meeting opened with a complaint that the project was not getting as much interest as it should. A suggestion was made by Thomas to open the wiki to non-Bocurious members and to move the wiki from the proprietary software that Biocurious used to the common open-source solution MediaWiki. He argued that by exposing our project, we could solicit technical advice and other forms of assistance from outside experts. Someone noted that the current wiki was protected by board directive and that we would have to discuss moving the wiki into a public space with a board member.[73] At that point, the topic was dropped and the wiki remained behind the Biocurious members-only wall. Another reason put forward for keeping the wiki private was publicity. We did not necessarily want to attract much attention and risk the negative publicity it might engender. Ultimately, we decided not to invite public discussion of the wider philosophical implications of genetic engineering, but rather to keep the project within the “garage lab” walls and ensure that our work meets safety standards of our own devising. We also agreed not to let anyone walk out the door with genetically modified organisms we might create. Our garage door would only open one way.

Next, we solicited donations for the project, and several people pitched in twenty dollars to help purchase the Modern Bio kit. We passed an actual hat around the meeting table and everyone dropped in a few dollars. Our plan was to conduct the experiment the kit enables, then clone the plasmid and use it for further experimentation under Kathy's guidance and supervision. The kit contained all the elements necessary to conduct the

[73] The wiki system used at Biocurious is commercial software donated as a favor by the developer to one of the board members. It is one of the many corporate donations operating behind the scenes at Biocurious.

experiment - *E. coli*, the lux plasmid, a control plasmid, plus test tubes, reagents, and a set of instructions. The kit was a well-designed and well-vetted experiment whose users, provided directions are followed, should have no problem producing a "matter of fact." After producing the fact, we planned to modify the plasmid as a base for future experiments.[74]

While the original impetus was to create a lamp that gives off light in accordance with bacterial rhythm, Kenneth opined that our objective instead should be to create a glowing sign for Biocurious. And so, after a brief discussion, the lamp Thomas originally wanted to make was abandoned in favor of creating a marketing stunt in the form of a glowing Biourious logo. When this idea was brought up, it initiated a philosophical digression over the aim of this project. Kenneth argued that the project was ultimately an educational exercise and that the glowing sign would add impact as a public demonstration of how synthetic biology might open new kinds of markets and products:

> That is not a vision . . . making signs the ultimate goal or vision, but is we have that as a technology objective either some sort of switch system. There are known circadian rhythm genes. If we can use that as a

[74] It would be more accurate to say that the kit we sought to obtain was not an experiment in the strict sense of putting a claim on knowledge at stake, but rather what Collins (1988) has called a demonstration, or "a public display of virtuosity," the public in question being the bioluminescence project members and those who follow on our outward facing email list.

> switch or actuator or whatever. That would be an amazing project. Think of all we would learn along the way.

In parallel with purchasing the Modern Bio kit, we decided to pursue obtaining a few select biobricks, which we can obtain through a contact in a local academic lab. Normally, obtaining biological materials like this would require a Material Transfer Agreement and some legwork, but our contact was willing to clone his repository of iGem parts for us after hours at his lab. Following that, a member from the project would pick the cloned repository up at the lab in a cool bag, then drive the biobricks to Biocurious. This operation required pirating the biobricks with all the attendant illegality. After this possibility was raised, the meeting switched gears and we discussed whether this was a route we wanted to follow.

At this critical juncture, Kenneth recounted the fable of Napster and iTunes. Without the invention of Napster, Kenneth said, there would have been no impetus to develop iTunes. The music industry needed Napster to teach it about the new world of digital music, and iTunes was that educated reaction. He noted the same phenomenon was at work in the early days of YouTube when most of its content was illegal. Illegality to teach a lesson is the way of the disruptive economy, Kenneth reminded us. Further, he argued that we would be doing both industry and government regulators a favor by pirating the iGem biobricks and using them to build a lamp or sign.[75] In fact, our piracy would be the necessary impetus for regulatory agencies and large corporate actors to step in and issue rules that everyone can abide by. Someone will do it. Why not us? This is the process, Kenneth argued, through which a dangerous technical development is brought to heel. By cloning the repository, we would be breaking the letter of the rules, but it would be in service to the greater good. The meeting ran late and Kathy, who had been nominated as the group's teacher the week prior, had to leave to pick up her son.

Third and Fourth Meetings. The third and fourth meetings were sparsely attended. The Modern Bio kit we ordered was finally delivered in the week of the third meeting, but it was not yet at the lab. By the third meeting, the enormity of the engineering task we had selected sunk in and we began to get caught in the enormous number of contingencies and details that accompany

[75] We did attempt to pirate the biobricks. But our attempt was completely unsuccessful. The parts made it to Biocurious but they were not able to be put to use at Biocurious. Again, the difficulty of using the DIY lab benches and the inaccuracy of the lab equipment were thought to be the cause, but it proved impossible to determine a satisfactory answer.

selecting a particular plasmid to work with.

As the details of pursuing new work quickly became overwhelming, and the logic of sticking with well-characterized model organisms quickly became apparent. To combat some of our fatigue and to help inspire new people to join the project, we decided to culture dinoflagellates. Dinoflagellates are a type of plankton that were easy to keep and could be made to glow simply by shaking them. They offered a concrete, if not completely satisfying, demonstration of bioluminescence for visitors. But, caring for them also took time away from the our *E. coli* intentions.

The Fifth Meeting. The fifth meeting took place during the height of the Google equipment anxiety. Unsurprisingly, a large part of the meeting was taken up by discussing what the Google equipment haul meant for life in the lab. Prior to the meeting's start, Kathy, myself, and a couple of volunteers were in the backroom discussing the Google equipment, which we found labeled and annotated. I shared what I knew about the annotations since I was present when they were made and I recounted what I knew of the board's design principles.

Kathy laid out a vision of how the Google equipment could be used to set up the kind of permanent equipment stations common to academic and industrial laboratories. However, she also noted that imposing order in a DIYbio space seemed essentially impossible; if people can't figure out the trash cans, she argued, DIYbio is hopeless. In her understanding, Biocurious was divided into opposing camps. The camp that got the equipment from Google wanted professional equipment and wanted the “garage lab” to operate like a "real laboratory." The camp that designed the “garage lab” was resistant to change. Kathy argued that adhering to the design of an academic or an industrial laboratory would raise participation and encourage more high quality projects at Biocurious. Experienced lab workers saw the homemade benches and made negative assumptions about people working here, she said. To the people who would be supporting and running classes, good equipment would communicate competence. At this point, our conversation was interrupted by a notice from the classroom that the meeting was about to start. We filed out of the backroom through the lab and into the classroom where the meeting was held.

The meeting’s initial topic was an unexpected difficulty with the Modern Bio kit. Information on the constitution of the plasmid in the Modern Bio kit proved impossible to find. Kathy offered the opinion that the companies who packaged these educational kits intentionally made identifying the specific plasmid difficult as a way to protect their investment in the kit. In our naivety, we had been tricked by the kit's designers. The kit included instructions detailing how to perform the experiment but did not include any reference information about the plasmid.

More troubles arose. The *E. coli* we planned to experiment on would need to be recultured every three or four days. If we ran the meeting every two weeks, this would be a problem. And there was more general dissatisfaction with the Modern Bio kit. As Kenneth explained, "I am not very happy with the educational kits because they aren't very valuable. They are valuable for high schools. They don't take you very far. I have done many kits. It's a recipe. It doesn't explain the science. Without a scientific experiment you can't expand on things." The kit was educational, but not in the desired manner.

The meeting was short that week and people began to leave as soon as it ended. The fact of the experiment arriving via kit argued against its status as experiment, as nothing new was set to be gained. The logic of the biobricks appeared again. Whereas the kit was not well-characterized - there was no blueprint for the included plasmid - the biobricks were. Hence, the biobricks lent themselves, in theory, to elaboration and further engineering.

After the official meeting ended, Thomas and Kenneth talked about plasmid in details as I started to take out the trash. This was a common occurrence and continued a growing trend; decisions about the course of the project were made outside of the weekly public meeting via emails circulated among a subset of project members. While the majority of the weekly public meetings were taken up with introductions and talk about peripheral aspects of the project like algae and dinoflagellates, decisions about pursuing bioluminescence were being made by a tighter circle.

Following the pattern of after-meeting meetings, Kathy and I talked outside Biocurious on the sidewalk. Kathy said, "If I got really involved with this [Biocurious], everyone would think I was a shrieking harpy." This would be Kathy's last project meeting and one of her last visits to Biocurious.

I would like to draw attention here to how the ability to participate narrowed as the project rolled through the spring. In small ways, the path to participation was made narrow. One way participation was narrowed was through decisions about the project made outside of the weekly public meetings. Another way was through making decisions late in the meeting after some members had left. For example, Kathy, the most qualified member by far, was unable to stay late due to outside responsibilities. Through a narrowing in the structure of participation, the bioluminescence project quickly became a project that was dominated by a class of entrepreneurial-minded men with backgrounds in startup companies and corporate engineering groups.

Making Suitable Experimenters

While Jane was excluded from the ranks of the volunteers through administrative action, a subtler mechanism of exclusion was operative among the members who ran the community projects. As I hinted in the last section, one form this mechanism took was in shifting the tempo and schedule of work on the project. When official project meetings ended, informal meetings continued both at Biocurious and in other quarters. As well, project work often took place during the early afternoon or late at night when those with other responsibilities were unable to participate. In this sense, the community projects ran on the schedule of the garage: as a space without set routines or outside responsibilities. Those without unlimited time and energy for tinkering slowly found themselves outside of the project and often left of their own accord. For example, on the night of our experiment, the normal meeting time was moved forward an hour through a murky decision making process. In reply, our erstwhile teacher Kathy sent an email indicating she could not make the earlier meeting time due to other commitments. This email meant that another teacher would have to be found before the experiment.

The experiment took place between 8:30pm and 9:30pm on March 12th, 2012. The date and time is consequential as the window to witness the success or failure of the experiment and to see the transformed bacteria glow in a dark room is approximately 18-24 hours after transformation, while the bacteria are in their log phase and the colony is expanding at an exponential rate. An email was sent that evening announcing the experiment to those who could not participate. The email announced that all subsequent communications about the experiment would also come via email.

As mentioned previously, the experiment took place during a scheduled Monday meeting, which started one hour earlier than normal. The meeting proceeded as had the others, with a roving and loose band of people participating in various ways. However, when it was time to don the gloves and perform the experiment, the field of possible participants would narrow further. The night of the experiment began by noting, in the brief meeting before the experiment, that some present were not paying members (I, for instance, was not a paying member but had membership extended to me for volunteering more than 20 hours per month) and so could not participate in the lab work. Others had never been given safety training and could not participate. While these moves narrowed the pool considerably (even though no board member was present to ultimately enforce the membership and safety training rules), another method would be employed for the final narrowing of experimental participants.

This community experiment was, in important ways, a culmination of the subtle shaping of participation in the project that had played out over the previous six weeks. Issues such as after meeting times and dates, what was communicated to whom and how about the project, and the whereabouts of the Modern Bio kit with its closely guarded instructions all played a part in shaping participation in the experiment. In turn, participating in the experiment would be a key rite of passage for further participation in the bioluminescence project. Thus, the evening of the experiment both demarcated the limits of one's participation and served to constitute the basis for further participation. The overlapping, sometimes discordant, conversations over what Biocurious might become were distilled into a single moment in which participation in our community experiment was manufactured and staged. Below, the final exclusion as an achieved result was crystallized in fifty seconds of conversation in the laboratory, as it was performed in the course of an experiment, which was a demonstration of both technical acumen and social status.

Experimental Authority in the "Garage Lab"

After arranging the kit on an adjacent table, the assembled bioluminescence participants organized themselves for experimentation. The initial moments were an exercise in gathering materials, arranging the lab benches, and focusing everyone's attention on the task at hand.

Figure 5.5: The Experimenters

Note the symbolic and material markers in Figure 5.5: the blue lab gloves, black clothing, and the agar plates on the table.[76] Immediately after this frame, a conversation took place between Edna (on the left of the bench), a volunteer, and Kenneth (to the right wearing blue gloves), a Biocurious member, over what was going to happen next.

Figure 5.6: What Is Happening Here?

A conversation about taking out the trash began at this time among those to the left of the experimental table. The image above captures something of the ambiguity of the experimental moment. Kenneth was wearing blue gloves and Jonah, a volunteer wearing red to the left of the frame, was donning blue gloves.

[76] We did not coordinate wearing black clothing. Yet I would argue that our clothing was not at all coincidental. Black clothing is a cultured response to demonstrations of technical prowess in Silicon Valley.

But are they for the same purpose? From this point, I will transcribe the brief conversation which ensued.

Figure 5.7 "Is everybody clear"

Kenneth: "Is everybody clear on what we are doing?
Edna: "No, but..."
Kenneth: "Hey. Listen"
(Laughter)
Edna: "You should say... are we interrupting?"
(Laughter)
Edna: "Oops, sorry"
Kenneth: "Hey, I just want to make sure you guys know what we are doing? I, huh..."
(Laughter)
Thomas: "Listen to the teacher."
(Laughter)
Kenneth: "I don't really want to be the teacher but [turns to Thomas]... That's usually your job"
Thomas: "You know a lot more about this than I do..."
Kenneth: "So, we are going to mix a little bit of the calcium chloride with the bacteria then we are going to take all the bacteria and put it back in the plasmid."

And with that exchange, Kenneth emerged as the de facto teacher and experimental leader.[77] The end result of this deliberation was that myself, Thomas, and Kenneth, all dressed in black and wearing blue nitrate gloves, would perform the experiment while the others gathered around the table would watch us perform the experiment.

[77] For a deeper look at how authorization is achieved in interaction, see Jordan (1992) and Varenne and Cotter (1996).

Meanwhile, Jonah, the volunteer who regularly fished the biowaste out of the trash stream, donned his blue nitrate gloves and proceeded to empty the biowaste bins. And with that participation in the experiment, and the "community project" more generally was set.[78] The pedagogical authority granted by Thomas to Kenneth during the course of this conversation drew a bright line excluding the majority gathered around the table from inclusion in the experiment. If participation in the experiment was shaped in ways both subtle and blatant and through symbolic and material status markers, the end of the experiment left the bioluminescence project with the related question of who may serve as witness to the results of the experiment and how witnessing the experiment was to be accomplished.[79]

Witnessing the Experiment. Immediately after the experiment, an email announcing the experiment and giving a few logistical details was sent to the bioluminescence Google group. It was sent by Alex, the project initiator, despite the fact that he only

[78] There are a number of other directions this analysis could follow. I have emphasized participation, but the difference between working in an open laboratory space as opposed to a more traditional laboratory is clear, since the project members spent the majority of their lab time searching for equipment, rather than working directly on the experiment.

[79] To witness the experiment is to be within the history of the experiment and to be included in the orchestration for the event.

watched and photographed the experiment and did not directly participate in the laboratory work.

Figure 5.8: End of Experiment Email

...

2) we finally did our luciferase transformation. we made 8 petri dishes, and the leftover liquid bacteria we put it with a little ampicillin in the remaining broth, so in the best case we obtain a glowing liquid culture, if everything went well.

3) updates most probably from pk/ c within the next few days.

Next meeting like always, monday 7.30 hopefully with some glowing bioluminescent culture of E. coli

Alex

Two days later, an email was circulated with pictures of bacterial colonies growing on the agar plates we had transformed. The email was addressed to the bioluminescence group in the main, not to specific members. The email greeting "hey together" was a linguistic invention suggested by Alex to rectify a problem with the English language.[80] The greeting also served to remind everyone that community projects were design to be inclusive.

This email was followed by an update from Kenneth a few hours later explaining where he had placed the petri dishes. Kenneth's email was specifically addressed to the member who initiated the bioluminescence project and to one of the experimenters. Even though I was one of the experimenters

[80] A native German speaker, Alex was struggling to find a 2nd person greeting in English to address the bioluminescence group. I suggested y'all or all'y'all, but Alex preferred his invention "Hey together."

(wearing black with blue nitrate gloves), I was not included in this email greeting. With this email, the circle of experimenters drew ever so slightly tighter.

The next day, Thomas viewed the agar plates and announced the failure of our experiment.

Figure 5.9: "we couldn't detect any bioluminescence"

Hi all,

We checked on the E. coli plates and the dinoflagellates during the BioPrinter meeting this evening.

...

The pLux E. coli plates have a lot of colonies on them, but we couldn't detect any bioluminescence at all. The instructions do say that colonies should be visible after 24 hrs in the incubator, and that the bioluminescence decreases after that, as the E. coli goes into stationary phase and presumably stop producing luciferin. So either something went wrong and we're not getting bioluminescence at all, or they've already stopped bioluminescing by now.

...

With this email, the witness appeared. Thomas, who had donned blue gloves and wore black during the experiment offered himself as witness. And he offered himself to the entire group by addressing the email “hi all.” But, this end to the experiment is ambiguous. Our *E. coli* might have expressed bioluminescence at a time when nobody was available to witness the phenomenon.

By March 19th, the next scheduled meeting time, the problems with our experiment had been traced to the incubation temperature, which was believed to have been too high for the *E.*

coli. The problem was noted in an email sent to the group by Thomas. And Thomas, rather than Alex, would from this point onward be the member who sent around the meeting notes and technical emails. This development marked a subtle, but telling, shift in the project. Shortly after this meeting, Alex would leave Biocurious to start an art-focused hackerspace in Berkeley.

Figure 5.10: "our bacteria grow fine"

1)our bacteria grow fine but dont glow.

probably because of a too high incubation temperature (37°C instead of 30°C/Room temperature) anyway the instructions say they only seem to glow in a specific time frame. we diluted some bacteria/brath [sic] mix and added new broth, keep it at room temperature to boost a new growth period for the mutated E. coli and hopefully get them glow in the next couple of days

...

This may very well be what is happening with our transformed E. coli! I think both the air incubator and the water incubator are set to 37°C...

To be fair, both sets of instructions we had did say to incubate in the dark at room temperature. But they also use a 37°C water bath for the transformation protocol itself. And the more detailed set of instructions does mention elsewhere "Luminescence is apparent at 18-24 hours after transformation when plates are incubated at 37°C or at 2-3 days at room temperature". Argh! Anyway - if that is indeed the problem, that's actually kind of an interesting and instructive error to make...

Thomas

The combination of poor instructions included with the Modern Bio kit (this begs the question of whether proper experiments can have instructions) and the uncertain functioning of the equipment at Biocurious creates a set of uncertainties about the outcome of our experiment that rendered drawing firm conclusions impossible. If the benefit of a laboratory is the exacting control it offers over the conditions of an experiment or demonstration, then the inability to exert control calls into question whether or not a laboratory can be said to exist. This was a point stated by Kathy on her last night at the bioluminescence project. But none of this meant that something new could not be assembled from the broken pieces of our experiment.

Witnessing Experiments in the “Garage Lab”

Four days after the end of the experiment was pronounced, an update about the flask containing the ampicillin-fortified "broth" we set aside during the experiment was sent by Kenneth. Unlike the agar plates, the ampicillin broth had not been incubated at 37°C but had been sitting on a shelf in the lab at room temperature, which was closer to 30°C. The broth mixture was purely an afterthought. It was placed on a shelf in the lab, covered in aluminum foil and like cooking stock, saved for future use.

On March 23rd, Thomas reported by email that the broth mixture was glowing brightly enough to be seen by the unaided eye:

Figure 5.11: "Good News!"

Hi all,

Good news! The flask of transformed pLux E. coli that we incubated at room temperature is glowing nicely! It was even brighter than the dinoflagellates, I think, and giving off continuous light rather than the flashes we're getting with the dinos.

Thomas

This note on the success of our improvisation off the instructed path was one of the few bioluminescence project emails punctuated with exclamation points.[81] While the experiment as designed by Modern Bio that uses agar plates as the bacterial substrate was witnessed to be a failure, our improvisation on the night of the experiment (creating the "broth") was witnessed to be a success. The steps taken to improvise this result were never quite explained, at least not in the public meetings. If one was not present at the experiment and not included in the closed circle of blue gloved members authorized to experiment, then the implications of the glowing "broth" were entirely unclear.

Even though the kit was designed to use a negative control, we did not use the negative control in our experiment, nor did we

[81] Though not stated in the email, the standard procedure for examining fluorescence or bioluminescence at Biocurious was to take the sample in the back bathroom and turn off the lights to see if it glowed, the back bathroom being the darkest room at Biocurious.

keep a lab notebook.[82] Hence, when the experiment failed, due to both our incomplete understanding of the instructions and lack of previous experience with the protocol, judging the success or failure of this experiment fell on the trustworthiness of those available to serve as witness.

Here the witness did not only witness the end of the designed experiment provided with the kit, but redesigned the original experiment by substituting the kit’s petri dishes and agar substrate for a flask filled with "broth." The success or failure of our experiment was ultimately of less importance than the success of Kenneth as a witness to our failure, and Thomas as witness to our success. Did the flask of "broth" light up through bioluminescence? No other evidence existed beyond Thomas' assurance that the flask did glow. Yet after his email, we proceeded as if it had.

Conclusion

Chapter Five examined the Bioluminescence Community Project at Biocurious. The chapter began by describing a contest at Biocurious designed to develop community projects that would

[82] By not using the negative control or keeping a lab notebook, we robbed ourselves of the two primary diagnostic tools used to determine experimental failure.

encourage activity in the "garage lab." One of the winning projects, the Bioluminescence Community Project, was initiated by an artist with a pressing need for light in his illegal living space. From this humble beginning, the Bioluminescence Community Project quickly transformed into a commercial project (re)designed to demonstrate Biocurious as the kind of Silicon Valley garage where new industries are created. The chapter ended with an explication of a critical look at the emergent process of experimenting and witnessing experiments at Biocurious. The question of who was allowed to participate in the experimental process was attended to through close attention the development of exclusionary mechanisms.

Chapter Six moves out of Biocurious to discuss the history of the FBI's surprising relationship with DIYbio.

Chapter Six

Demonstrating Biocurious for the "New FBI"

Overview

This chapter takes up the relationship between DIYbio and the FBI in the context of a jointly sponsored conference organized by the FBI in conjunction with Biocurious. The FBI's interest in DIYbio was spurred by the diffusion of genetic engineering from tightly controlled academic laboratories to kitchens and garages in combination with the post-9/11 focus on preventing terrorism. The “new FBI” responsible for organizing the conference employs scientific experts with advanced degrees and seeks to establish ongoing relationships with DIYbio laboratories in the interest of ensuring safety. Far from being "the next big thing out of a Silicon Valley garage" Biocurious presented to the public, at the FBI conference Biocurious is presented as an older statesman who has faced and overcome the difficulties of running a DIYbio laboratory. This chapter closes with a look at the FBI’s role in spreading and incubating the global DIYbio movement.

A Prehistory of the FBI and DIYBio

The FBI has been aware of DIYBio since at least 2004 when an artist, who had undertaken a biology-inspired project which required building a small laboratory in his house in upstate New York, was raided by an armed team of FBI agents following his wife's untimely death. In the heated policing environment of 2004, a call by the artist to 911 about his ailing wife ended with drawn guns, hazmat suits, and years of legal wrangling before the artist was able to clear his name. The specter of FBI agents in hazmat suits bursting through garage and kitchen doors, and the possibility of a felony sentence cast a long shadow over the early years of DIYBio.

Yet by 2009, DIYbiologists, such as Mac Cowell and Jason Bobe had established a relationship with the FBI. As public labs began to open, the FBI deepened their initial relationships with DIYbio by inviting DIYbiologists to participate in a series of joint conferences. The first few were held in concert with existing synthetic biology conferences. But eventually, the FBI decided to hold conferences specifically with and for DIYBiologists.

Hanging over DIYBio, in the FBI's reckoning, were the anthrax attacks of 2001. In a 2001 news conference, officials from the FBI claimed that anyone with moderate scientific knowledge and $2,500 worth of "basic laboratory equipment" was capable of creating the anthrax used in the 2001 attacks. And FBI experts speculated that a lone individual had committed the attacks by creating anthrax in the privacy of a kitchen or garage. A decade on, after a National Academy of Science investigation and extensive attempts by researchers at national laboratories to trace the origin of the anthrax used in the attacks, the culprit, or culprits still remain unknown. Biology is a fickle discipline. Hence, the FBI felt a new security strategy was needed to prevent a repeat of the 2001 anthrax attacks. The "old FBI" strategy of kicking down doors and rounding suspects would have to change.

Early Engagements

The first FBI/DIYBio conference was organized by Genspace in New York. At this time, Genspace and Biocurious had both acquired a regular FBI field agent who served as liaison between the labs and the FBI. The FBI liaisons at both labs came with biological backgrounds and scientific dispositions that made for easy relationships.

During these early meetings, a new idea of policing emerged as a factor in the relationsip between DIYbio and the FBI. The "new FBI" would befriend DIYbio labs and recruit them into their surveillance network rather than break down their doors in the wake of an incident.

Safety Through Surveillance

A question naturally presents itself: Can the "new FBI" be a friend? One advantage of the "old FBI" is that it was tame, in this sense of being predictable. Break a federal law and expect an FBI agent or team to break down your door. The "old FBI" had a track record of seventy years. But the “new FBI” is a mystery.

The move made by the "new FBI" tracks two intersecting design elements. First, it tracks the design of the new national security apparatus in the post-9/11 environment based on surveillance and diagnosis. Second, it tracks the peculiar panoptic approach to management found in the Biocurious design language: the ability to survey at a glance, to recognize the intent of an experiment by a reagent order or conversation, and the deployment of transparency a management tool. These are all commonalities. All play their part within the "new FBI" and the design language for security in a post-9/11 world. As The FBI produced brochure distributed to DIYbiologists at the conference explained: “Scientists and laboratory managers need to be aware of these threats and understand the warning signs of potential targeting. Just as medical doctors use signs and symptoms to identify diseases, scientists can learn to identify suspicious activity and report it to law enforcement.”

We can fruitfully consider the "new FBI" as a design in Flusser's (1991) sense. That is, the new mechanics of policing (any technique of policing) are transmechanical, spreading out and across the intellectual operations of policing, crossing old boundaries and creating new boundaries while instantiating unforseen configurations of policing.

The 2012 FBI/DIYBio Conference

In 2012, an FBI/DIYBio conference was scheduled on the west coast with Biocurious as a sponsor. Due to an obscure government regulation about what kind of hotels could be used for government conferences, the 2012 FBI/DIYBio conference was held in Walnut Creek, approximately 75 minutes by car from Biocurious.

My initial encounter with the FBI came as I checked in at the front desk. On the first day of the conference, an FBI agent asked me if I was with the FBI. I was initially taken aback but eventually I ended up with Biocurious credentials and was allowed into the conference.

I had arrived at the start of a long series of presentation from DIYBiologists brought to Walnut Creek by the FBI from the Americas, Europe, and Asia. There were presentations about specific projects mixed together with presentations about the organization of new and existing laboratories. They came in one long string lasting four hours.

The first presentation was on the development of a low cost DNA synthesizer for DIYbio, which was largely theoretical. Next, Mac Cowell presented the diybio.org website, billing it as "a way to connect the community." A duo from Chicago presented an open science organization with long-term plans to become a publisher in the DIYBio space.

The last presentation prompted an interesting question about federal regulations governing DIYBio, directed to the FBI agents. The FBI answered that most regulatory compliance issues affecting DIYBio (in the United States) existed at the local, not federal or state level. In the discussion following this question, someone suggested that an online repository of regulations similar to one started by backyard chicken farmers would be a good idea.

Presenting Biocurious

Soon, it was Biocurious' turn to present. The board member with the human resources background was the designated presenter. She presented Biocurious as a volunteer-driven and volunteer-organized organization. A slide titled "Tribes of Biocurious" followed this declaration. This slide claimed that Biocurious consists of 33% entrepreneurs, 33% technology workers and 33% next generation scientists (this was the first time I heard the phrase "next generation scientist"). The following slide was further broken down into a set of marketing personas with names like "moonlighting hobbyists" and "low-cost advocates." This was my first encounter with Biocurious as it had been presented to regulators, policy makers, and corporate executives. Needless to say, I hardly recognized the Biocurious I knew in this presentation.

Following the questionable demographic breakdown of participation at Biocurious came a slide presenting Biocurious sponsored activities. The activities included "Training Series," "Biotech Bootcamp," "Biz of Biotech," "Founder's Tales," and

"Saturday Morning Science." Outside of "Saturday Morning Science," which was a series of science demonstrations for children on Saturday mornings, I had never heard of these events before.

The next topic addressed was safety. Safety was presented via a list of bullet points: A Maze of Regulations, No Editorial Control on Experiments, Meet Safety and Legal Restrictions, Community Oversight, and Transparent Lab Architecture. Each bullet point was given a sentence or two of explanation before the next slide was presented. The design language was not explicitly mentioned, but it was present during a brief discussion of the difficulty incorporating the Google equipment, with its beige color scheme, into Biocurious.

The next few slides followed the standard Biocurious media argument about democratizing science and providing a space for the community to experiment together. In standard startup fashion, a story about the first class at Biocurious was related to the “new FBI” and assembled DIYbiologists. In their telling, the first class ended with the another board member's surprised reaction, "Oh my God, this might actually work." This section of the presentation hewed closely to the "next big thing" verbiage deployed during the crowdfunding campaign.

Finally, the topic of volunteering at Biocurious emerged from the slide deck. Volunteers, like safety, also got bullet points: Motivations are Different, Experience for Time. The board member explained that waves of volunteers had come and gone from Biocurious and said, "the people who get you there don't always get you to the next level." The last sentiment I could only read as a comment on the fate of Jane and the members and volunteers who left or retreated from Biocurious in the wake of the spring's contentious conflicts. Following a few words about local regulations and the process of finding a municipality willing to allow Biocurious to operate within its limits, the presentation ended. No question came from the audience.

After the Biocurious presentation came still more laboratory presentations. The presentations included the well-known Genspace in New York and Bosslab in Boston, but also labs operating in Baltimore, Victoria (CA), Manchester UK, the Netherlands, Paris, the Czech Republic, and Indonesia. Much of the presentation revolved around similar themes: the difficulty of finding equipment and reagents, decisions about how to organize and support the laboratory, the difficulties of finding a suitable space, and negotiating local regulations. At least for the North American labs, most are small, with a handful of members forming the core of the lab.

A few interesting variations were presented, though. The lab in Baltimore started as an offshoot of a community college laboratory and wanted to continue in that vein. They viewed DIYBio as a educative practice. The lab in Manchester was housed around the corner from the flat where Engels wrote *The Conditions of the Working Class in England*. The Manchester group was not organized around a membership model, but rather relied on the largess of a kind landlord and support from the Wellcome Trust and a local university. While they had access to sources of funding not available to the North American groups, they also were unable to tinker with organisms on a whim. The Amsterdam group was housed in the room in which Rembrandt painted *The Anatomy Lesson of Dr. Nicolaes Tulp*. The Dutch group took time to explain the set of regulations governing their experimental program. They were subject to three interweaving levels of regulations and must obtain and maintain several permits and certifications in order to run experiments. Additionally, the Dutch group was required to have a safety manual of no less than 400 pages and to name a safety officer who was personally responsible for ensuring safe and ethical experimentation in their lab. Later, a group from Paris revealed that they also had extensive support from the city.

If the North American and European Code of Ethics indexed a set of divergent sensibilities over the possible course of

DIYBio, then the regulatory differences between North America and Europe lent material reinforcement. The labs' respective attempts at humor also indexed this divergence. Whereas the North American labs all joked about being mistaken for a meth lab by local police and pleading with municipalities for permits to operate, the European labs joked about having too much paperwork to do and not enough time to experiment.

One of the final presentations in the lab series was given by Denisa Kera, who presented on DIYBio in Indonesia and Singapore. She talked about the network of DIYBio labs in Asia and discussed how their objectives differed from the American and European labs. Primarily, this difference was seen through their ambiguous relationship with GMOs. Are GMOs a point of confluence with academic biology, as they are for American or European DIYBiologists, or a an organism to be hacked and returned to s state of nature? Following Kera was the Indonesian group, House of Natural Fibers (henceforth HONF). They showed a promotional video for the HONF which had nothing to do with DIYbiology. This presentation (of sorts) would be their last appearance at the official conference.

After the presentations, an FBI agent announced from the banquet room that the next day would consist of security scenarios around issues that might come up at the intersection of law and DIYBio.

A Countereducation into DIYBio and the FBI

While the FBI was busy lobbying the attendees, a counter education of sorts was taking place in the inevitable round of informal meetings that were held outside the bounds of the conference room. A good portion of attendees must have taken note of the FBI warning sign during a side trip to Noisebridge, a hackerspace in San Francisco, and no doubt even more discussed strategies for working with or around the FBI over dinner and drinks in between everyday concerns about finding landlords, insurance agents, and dealing with local regulatory agencies.

That evening I went to a warehouse party in Oakland where many of the DIYBiologists met to drink and discuss the issues of the day. The main topic of the evening was how to make a DIYBio lab sustainable. Everyone agreed that the membership model was not sustainable over the long term except in exceptional circumstances. As well, managing a lab required a full-time point of contact but finding a financial model that would support someone to do so full-time was a problem that nobody had yet figured out. Other options included recourse to wealthy individuals, corporate sponsorships, and holding regular classes for diverse audiences. These were all issues that were on full display inside Biocurious but kept hidden from the carefully managed media and policy audiences.

Presenting the "New FBI"

At several points over the three days of conference, FBI agents started their remarks by pointing out that they worked for the "new FBI," which operated in a different manner than the "old FBI." A few times FBI agents stood up and gave personal testimony to the difference between the new and old FBI. One in particular noted that the majority of agents at the conference were hired post-9/11 and had no firsthand experience of the old FBI. The dividing line between old and new, per the agents' testimony, were the string of events leading up to the 9/11 terrorist attacks. It was not the actual attacks per se, but rather the activities of the attackers around the US in the months leading up to 9/11, which marked the point of departure between old and new FBI and served as the reason the FBI spent lavishly to fly almost sixty people to the Walnut Creek Marriott Hotel for a 3-day conference.

Session attendance was far lower on the second day than on the first day. Later I would learn that the majority of the DIYBiologists flown in from Europe and Asia had skipped the second day of the conference in order to visit San Francisco, a short trip via train from the conference hotel. To start the session, an FBI agent announced that the purpose of this day was to "reinforce sharing and cooperation between the two communities [of the FBI and DIYBio]." This sharing and cooperation would take the form of scenario training. The FBI would offer a variety of scenarios for the assembled DIYbiologists to work through, while the FBI agents listened and assessed the conversation.

The security scenarios presented by the FBI were utterly fantastic and betrayed the deep divide between how DIYbio and the FBI perceive security and the scientific process. In one scenario, a speculative DIYbiologist returns from Asia (which country or countries was left out) and begins asking her fellow DIYbiologists for papers about the poison Ricin. This scenario was met with scattered chuckling and much head shaking. The FBI agents asked what a proper course of action might be. An answer was given, "confront them in a friendly way," and "this is the same problem as someone not sharing their project." Having passed this test, the FBI agent next asked about heated political conversations in the lab. Is there an anarchistic bent in DIYBio? Can a meaningful difference be drawn between a DIYBio lab and a hackerspace? These inquiries were met with the same stock answers, all of which seemed to satisfy the “new FBI.”

During the break following the security scenario, a Biocurious board member told me that nobody had bothered to clean Biocurious and that the lab was out of biowaste bags. He said it would be “interesting” when the conference attendees take a tour of Biocurious with the FBI in tow.

Following the break came another round of laboratory presentations, again with a mix of laboratories and projects. The projects were largely similar to the projects presented on the first day. But the laboratories continued to surprise with their diversity and research interests. DIYBio labs in Los Angeles, Newcastle, Helsinki, Germany, and San Diego, Redding, Turkey, and Denmark presented. Here, another distinction quickly became evident; some labs were highly focused on critical engagements with bio-art and others on profitable engagements with industry and the American military. The Finnish lab, in particular, had pushed the critical and legal boundary by conducting an art project around the topic of when death begins.

One DIYBiologist from Denmark opined that Denmark was one of the easiest European countries to work in, because of both the political climate and the ease of establishing a friendly relationship with regulatory officials. He remarked that many questions could be cleared up simply by inviting someone from the regulatory agency to discuss regulartory ambiguities over a cup of coffee.

The group from Berlin talked about their association with the Chaos Computer Club (CCC) and the anarchist spirit the CCC embodied. They described themselves as a small organization of frustrated PhD students who organized in the spirit of free inquiry. The group in Turkey, similarly, was a loose confederation of students organized around their interest in evolution and genetics. In the following discussion about organization, a Genspace member commented on the prevalence of business incubator/laboratories in North America by wryly noting, "I want to be a scientist, not a landlord."

A Tour of the "Garage Lab"

On the third day, the FBI/DIYBio conference moved from Walnut Creek to Biocurious. When I arrived at the lab, there were twenty to twenty-five people milling about. I recognized several Genspace members, some from the London lab, the Boston lab, and the Baltimore lab. It seemed almost everyone made the FBI arranged shuttle down to Biocurious, except for the members of the Indonesian lab House of Natural Fibers. There were four FBI agents as well and a representative from a defense funding agency, who had given a special talk on government contracting opportunities in the biological sciences the evening prior.

Eventually, a tour of the lab was organized and everyone stepped across the blue tape into the laboratory. A few DIYBiologists looked under the DIY lab benches and pushed down on the bench tops. Then the bench tops themselves came under some scrutiny. In the end, the DIY benches were a topic to be passed over in laborious silence.

After the laboratory tour, I settled into the now empty laboratory to do some work on a side project I was pursuing with another volunteer. We worked just across the blue tape from a Genspace member. As we prepared for our day of lab work, I struck up a conversation with the Genspace member about DIYbio and the relative difficulty of biology. She offered an interesting opinion: plasmid preparation, one of the main laboratory skills, is not particularly difficult. A member at Genspace, she offered, was as skilled at plasmid preparation as anyone working in any academic or industrial laboratory despite having no formal background in biology. I pointed out that several members of Biocurious became skilled at it as well. She said that it was not exactly rocket science; knowing how to organize an experiment and formulate follow-up work is the more difficult skill to learn.

I told her that we were working on a project about dandelion speciation, attempting to figure out if there were twenty or two thousand species of dandelions in the Bay Area. She reminisced that as a graduate student, her driving interest was in understanding natural processes and she had tried to bring this to DIYbio. Unfortunately, DIYBio seemed to be a place only for those interested in the technology for the sake of technology.

After we finished our preparation, I found an opportunity to talk with an FBI agent who had been watching us work. Because this was the last day of the conference, I asked him directly what the FBI was hoping to come out of this conference. The FBI was looking to build relationships because they knew they would not be able to see everything and they wanted to use the DIYBio community as an extra set of eyes and ears. Prior to 9/11, the FBI waited for something to happen. But post-9/11, the FBI assumes something is going to happen and works to establish the kind of relationships that might preempt an incident. He also argued that DIYBio should not be afraid of the media fallout of working with the FBI. This last comment struck me as wishful thinking.

How the "New FBI" Spreads DIYBio

If the formal session with the FBI were stilted and potentially dangerous, the informal presentations were gave a brief peek into the diverse activities among the DIYBio labs and the multitude of ways a lab can be organized. DIYbio activities ranged from traditional wet lab science, to all manner of engineering projects, to bioart, educational efforts, and philosophical and design inquiries into the nature of life. This was taking place in spaces ranging in size from converted bathroom stalls to large office buildings. Anywhere with cheap space and interest seemed to be a candidate for a lab conversion, whether that space was an old warehouse, a bathroom, or unused space in an existing hackerspace, and whether that interest came from a group of PhD-level researchers, an artist collective, a designer, or a group of aspiring entrepreneurs. Methods of organizing a lab ranged from anarchist collectives like the Chaos Computer Club and Noisebridge to customer-centric models based on makerspaces like Techshop, with most labs seemingly organized around some combination of membership (with its rewards and obligations), classes, and donations. One commonality was that the recent change in sequencing technology had left a glut of first wave biotech equipment available to be donated or purchased cheaply.

By hosting this conference, the FBI emerged as one of the most important institutions in the diffusion of DIYBio. The number of people doing DIYBio of any kind is a statistically meaningless number. Globally, no more than a few thousand people would have worked in a DIYBio lab, and of that number, a far smaller number would have carried out a sustained project. The number of people involved in DIYBio is small enough that DIYbiologists can get to know one another on a personal level during a conference. Of course, this can only become possible if an organization with deep pockets is willing to fly everyone to the same location so they can trade presentations and talk amongst themselves. With no academic or industry organization to sponsor them all, the FBI conference was the only way DIYBio can have a venue to share ideas and socialize face to face. Next year, there would be more DIYBio labs and they would be better organized and the projects more involved, in large part due to the FBI. This too must be a central commandment of the new FBI: help spread that which you wish to police and your budget will never be lacking. A more ominous consequence was the implicit connection drawn by the FBI between DIYbio laboratories and flight schools with the assumption that DIYbio laboratories may be breeding terrorists along with bacteria.

While the FBI was out to build friendly working relationships with DIYbio, the tacit admission that a DIYbio laboratory was a potential threat and that DIYbiologists, if not exactly assumed guilty, were not exactly assumed innocent either was a new and consequential fact of living with the new FBI. The FBI directorate covering DIYbio falls under the rubric of weapons of mass destruction and brings the harshest punishments the US government can offer. Further, it was not at all clear how the FBI kept tabs on the DIYbio community or with which other US government agencies (or foreign governments) they might share information.

This brings up the question: How are we to understand the "new" FBI?" What kind of organization is the redesigned FBI?

Conclusion

This chapter argued that the FBI helped spread DIYbio by offering DIYbiologists an opportunity to meet face to face. The depth of the FBI's interest in DIYbio and the extent of Biocurious's cooperation with the FBI reveal two intertwined threads connecting the spread of DIYbio with the role of the "new FBI." Without FBI sponsored conferences, it would be difficult for DIYbiologists to arrange an international conference, as DIYbio lacks the infrastructure to fund and organize an international conference. In this way, the FBI serves, perhaps unwittingly, as both infrastructure for DIYbio and as an enforcer of safety precautions within DIYbio.

Chapter Seven

The Afterlife of Yesterday's Next Big Thing

Overview

Th opening section of this chapter recapitulates the ethnography in light of the orienting dynamics identified in Chapter One. The following section examines the state of Biocurious today. New DIYbio labs formed by former Biocurious members and board members with new projects are expanding the reach and sophistication of DIYbio. Far from being "the next big thing out of a Silicon Valley garage," Biocurious today is a well-worn institution whose novelty has faded.

The chapter then addresses the three dynamics identified in Chapter One. In contradistinction to the amorphous effects designing and presenting Biocurious, efforts towards democratization have yielded concrete results, not necessarily in the direction intended by the original board. The final section addresses the more complex and ambiguous processes of a) design in producing and making Biocurious visible as a "garage lab," and b) the business of presenting Biocurious.

Recapitulation of Ethnography

I entered Biocurious as it was in the midst of transforming from a nomadic Meetup into a static "garage lab." My initial entrance came during a clean-up event held prior to the laboratory's opening, leading directly to an invitation to attend volunteer orientation. Following orientation, I was given a key to Biocurious and signed up for the initial volunteer shift. Through the fall and winter of 2011, I worked several volunteer shifts per week at Biocurious before slowly shifting from volunteering to participating as a de facto member of the “garage lab.” During the initial volunteer orientation, Biocurious, a self-described "garage lab," situated itself within a long tradition of inventive spaces, including the Library of Alexandria and Thomas Edison's laboratory. In the course of orientation, the guiding mantra of "stupid is OK, illegal is not" was introduced by Biocurious' board members in the context of serving the broader focus on customer service and branding. In the privacy of the "garage lab," sort-of illegal, or at least ill-advised, was OK as well.

Biocurious was then situated within the history of "next big things" emerging from the garages of Silicon Valley. To this was added a history of DIYbio, emphasizing DIYbio's emergence as a type of amateur synthetic biology first taken up in kitchens and garages. These two historical threads come together in Biocurious' creation of a "garage lab," made recognizable by historic precedent as a product of Silicon Valley and of DIYbio. After situating Biocurious historically, the ordinary business of design in making the "garage lab" recognizable as a particular type of laboratory was addressed. Chapter Three demonstrated how the design language at Biocurious was used to discipline the actions of volunteers and members and the understandings of visitors and media audiences.

In Chapter Four, series of acrimonious conflicts between the board and members of Biocurious over governance of the "garage lab" was recounted. Though often tense, these conflicts remained internal to Biocurious. Visitors and media audiences were shown a carefully constructed and curated version of Biocurious even at the height of internal conflict. For instance, the wine glass incident and the mysterious appearance and disappearance of the Google equipment stayed inside the closed circle of volunteers, members, and board members.

The design language served to erase the conventions of academic and industrial laboratories inside the “garage lab.” At Biocurious, benches were not steady in use or level in bearing.

Swaying and sagging were the norm. Pipettes were rarely calibrated. Biowaste was not handled according to the accepted convention until it threatened to overrun the storage space. Close enough was good enough in a “garage lab” that replaced the enunciation of scientific truths with the experience of science.

Outwardly to the media, policy researchers, and FBI agents who joined for an afternoon or a weekend experience, the "garage lab" was presented as an open space for innovation. Where the media, indirectly, and FBI, directly, possessed the power to regulate Biocurious, the careful stage managing of their visits meant that they saw only a curated slice of Biocurious. This policy went as far as to asking volunteers to come to the lab and pretend to perform lab work for visiting media. And this strategy was wildly successful. Media stories about Biocurious were rarely critical. Policy reports were always encouraging. The Woodrow Wilson Center wrote a positive review of DIYbio, and Eri Gentry was awarded a medal for scientific innovation at the White House while I was at Biocurious.

Little may have come from the experimental programs at Biocurious, but many volunteers and members were successful enough in scientific experience(s) at Biocurious to change careers, gain promotions, or parlay their “garage lab” experience into graduate school. As well, people who might not otherwise have worked in a laboratory worked at Biocurious. If "stupid" is conventionally taken to be an ill to be erased through instruction, the deployment of "stupid" at Biocurious was often productive. Within the small but protected bubble of "stupid" at Biocurious, ideas, people, and science were allowed to mix and mingle in new and unexpected ways to new and unpredictable effects.

Biocurious Today

Figure 7.1: The Blue Tape Today

Today, Biocurious remains next to the old AMD plant at in Sunnyvale, CA.[83] While little has changed from the perspective of

[83] AMD recently announced it was closing the Sunnyvale plant. In reflection of the current state of Silicon Valley, the area around Biocurious is today now up by condos and one mysterious building operated by Apple Computer.

the casual visitor, many of the contentious aspects of Biocurious discussed within this dissertation have been settled and formalized.

Perhaps the most substantial change has been in the composition of the board of directors. Four of the board members who were active at the space during the first two years of Biocurious have left. Some left under contentious circumstances, and others went quietly. Joining the two original board members on the board today are a long-time volunteer who focuses on community outreach and marketing and a long-time member who focuses on safety and serves as a de facto lab manager. The corporate workshops, so secretive during the initial years of operations, now have their own page on the Biocurious website.[84]

Figure 7.2: Corporate Classes at Biocurious

Top Innovative Companies Learn at BioCurious

There's a new type of innovation going on at BioCurious. The projects that happen at BioCurious are mind blowing. A 3D printer for biology, house plants that glow in the dark, cow's milk without cows.

This stems from our "open innovation culture", and we think it can help your company too, even though you're probably not in the biotech industry. We'll teach you how you can take this energy back to your own company and exceed everybody's expectations.

...

Policy Roundtable Discussion with your team

We also draw a lot of interest from policymakers, interested in innovation and biotechnology itself. We've been here since the

[84] Found at: http://biocurious.org/workshops/

beginning and we love to share our experiences and insights with different government groups, politicians, analysis. We've had representatives from the White House, Swedish Foreign Ministry, Science Ministry of the UK. All these people coming to learn about "what does policy look like for biotechnology?". "What does policy look like for innovation?"

Government officials, corporate executives, NGO senior staff, and others in the policy and innovation world can spend an afternoon as a tourist at Biocurious, where they are given a whirlwind overview of a biotech Tomorrowland. In this sense, the close attention to customer service and the distinction between front stage and back stage activities driven home at volunteer orientation have become central to Biocurious' financial life. And due to the steady stream of innovation workshops held at Biocurious, Biocurious is in excellent financial health. No longer does Biourious need member dues to keep the doors open.

The financial security provided by the innovation workshops has had a curious effect. Rather than reinforcing the design language described in Chapter Three, Biocurious today is a cluttered working lab where old and new equipment intermingle among numerous junk piles and experiments in progress. The few trained biologists working in the lab tend to use Biocurious for basic proof of concept experiments and take more technical experiments elsewhere. The aesthetic designed to attract corporate sponsors has given way to a shabbier aesthetic, which corporate and government workshop attendees can still understand as a "garage lab" experience. The design language is still operable at Biocurious in limited capacity, even if the aesthetic has shifted enough to allow members and volunteers to get on with their own work.

Volunteering at Biocurious is a less stressful experience today. Gone are the mandated business hours that accompanied the first two years of the lab. In their place has come a new entry system and an automated sign-in system. Members and volunteers are given access to a keypad entry system and sign in via a tablet computer at the front desk. Volunteers are no longer under the same pressure to sit at the front desk and wait.[85] It is conceivable that Biocurious could now find a place for Jane to volunteer around the lab and in the back room. Tom, who left in the wake of the Thiel Fellows debacle, has recently returned to Biocurious and is once again tending to the equipment. And others who cautiously moved to the shadows in the first two years have returned to play important roles at Biocurious - some taking over safety training and equipment sourcing and others leading new classes and projects.

[85] Though on a recent visit to Biocurious, I was sitting in the classroom when the front door chime sounded. Without thinking, I stood up and took a few steps towards the front desk. The original volunteer training was stressful but durable.

Biocurious' nonprofit status, which was a much discussed question mark during my fieldwork, has been resolved. Their 501(c)3 status is advertised in the Biocurious website footer.

Figure 7.3: Biocurious Website Footer

About Us BioCurious is a community biotechnology laboratory. BioCurious is a 501(c)3 nonprofit located in Sunnyvale, CA.

In sum, Biocurious is a more motivated category than it was when I sat for my first volunteer shift. Along with many of the quieter organizational aspects becoming formalized, a few of the same volunteers and members who joined Biocurious during the course of my fieldwork remain active at Biocurious. One of the two original community projects, the Bioprinter Community Project, still meets regularly. Taken together, the institutional knowledge provided by the presence of long-term volunteers, members, and board members, along with the new financial stability, has allowed Biocurious to become a stable, and well-respected, educational institution within Silicon Valley. But this stability and peace has come at a cost, Biocurious is no longer "the next big thing."

New Projects

Biocurious has settled into the predictable pattern of holding classes for members, orienting new volunteers, and holding workshops for visitors. Beyond Biocurious, DIYbio has continued to change and evolve. One new project, discussed below, and five new laboratories, discussed in the next section, illustrate these changes.

In 2013, the Glowing Plant project, an offshoot of the Bioluminescence Community Project, grew out of the lab at Biocurious and into a controversial startup company. The three Glowing Plant founders met at Biocurious. The technical founder had recently finished PhD in molecular biology from nearby Stanford University. Another founder was doing post-doc research at Stanford and building computational tools for assembling DNA sequences in silico. The final founder had an MBA and long experience as a Bain consultant. Together, they attempted to create a platform for bioengineering plants. Their initial product was to be a plant-based lamp powered by bioluminescence. If this idea sounds familiar, it is because Glowing Plant was the Bioluminescence Community Project transposed from a bacterial plasmid into a plant. To give a brief technical overview, Glowing Plant intended to take a luciferin system from the marine bacteria vibrio fischeri found in squid and insert it into an arabidopsis plant, thus causing the plant to bioluminesce at night. Once an adequate amount of light has been built into the plants, plants were to be offered for sale directly to consumers. Perhaps surprisingly, this is completely legal and unregulated by the USDA within the United States.[86]

Whereas Biocurious was able to raise $35,000 dollars via Kickstarter in 2010, in 2013 the Glowing Plant project raised almost $500,000 via Kickstarter based on the strength of a clever pitch, a viral video, and the backing of a public relations firm who helped to create media coverage. For a time, Glowing Plant eclipsed Biocurious as "the next big thing out of a Silicon Valley garage."

Despite starting out at Biocurious, the Glowing Plant Kickstarter campaign was sponsored and supported by a number of startup companies associated with Singularity University, and it maintained close ties to Singularity University's startup ecosystem.[87] In this sense, Glowing Plant follows the classic Silicon Valley pattern of the well-supported disruptive startup

[86] Because arapidopsis is a model organism and neither an agricultural product nor pest, the Glowing Plant project is unregulated by the USDA. Here, the principle of liberty, rather than caution, applies. Stupid is OK, if not expressly disallowed.

[87] The original Biocurious board members also had close ties to Singularity University, and Singularity University had supplied the majority of clients for the early corporate classes and workshops which supported Biocurious. Singularity University is not a university per se. Rather, it is a think tank offering corporate education and retreats that is focused on the second and third-order effects of what it refers to as "exponential technologies." It was founded by a small group of entrepreneurs, including the futurist Ray Kurzweil, in 2008.

pioneering a new market, direct to consumer synthetic biology in this case, by forcing a product through a regulatory grey area.

Glowing Plant posed a challenge for Biocurious, as it threatened to attract unwanted attention from both regulators and anti-GMO activists. For a period of time, whether or not Glowing Plant could operate out of Biocurious was a difficult topic for all sides. Glowing Plant eventually moved to a private laboratory in San Francisco. Ironically, the departure of Glowing Plant from Biocurious occurred over a disagreement about Glowing Plant's liberty to tinker versus the responsibility of DIYbio experimenters to the larger ensemble of DIYbio laboratories. In the opinion of the Biocurious board, stupid was not OK for Glowing Plant.

Today, Glowing Plant is defunct, having never shipped any of its promised plants to the thousands of people who donated almost $500,000 during its Kickstarter campaign. Though Glowing Plant may have failed, its trajectory paved the way for new types of projects to emerge out of the new for profit DIYbio spaces, such as Indie Bio and Berkeley Bio Labs.

While Glowing Plant was the first project to escape the blue tape at Biocurious, new DIYBio laboratories (discussed in the next section) have opened, and new kinds of DIYbio projects have appeared. Projects such as Real Vegan Cheese and Open Insulin have drawn teams from multiple DIYbio labs and are organized in a more egalitarian manner that accounts for both the needs of experienced hands on the project to forge ahead and newcomers to the projects to find a foothold. Unlike Glowing Plant, neither of these projects is explicitly commercial, though there is no mechanism, other than a convincing argument and a spirit of communitarianism, to prevent a commercial project from spinning off.

Increasingly, Biocurious has established ties with DIYbiologists in Latin America, regularly hosting video conferences to discuss joint project plans and member exchanges. Many of the same conditions that allowed for the creation of Biocurious in Silicon Valley are present in Latin America - a surplus of laboratory scientists, availability of equipment, and a dearth of academic and industry jobs. Biocurious' location in Silicon Valley and its openness to visitors, be they in person at the physical lab or attending via video conference, mean that almost any interested party can collaborate in some way with Biocurious or seek counsel and advice about running a DIYbio space from the old hands still active and involved in the everyday business of operating Biocurious.

New Labs

When Biocurious opened, it was one of only two DIYbio laboratories in the United States.[88] Today, three additional laboratories in the Bay Area, one in San Diego, and another in Carlsbad have been started by Biocurious alumni. Given the intensity of conflict at Biocurious over the governance of the "garage lab," it is not surprising that Biocurious alumni would move out to start new laboratories. If Biocurious was a new thing that brought together a group of people with divergent ideas about the "garage lab" ideal, the laboratories opened by Biocurious alumni have allowed those differing ideas of what DIYbio might be to find an expression.

The laboratories below were all started in an 18 month period coinciding with the end of my fieldwork at Biocurious. A short list of DIYbio spaces and their associated creeds stemming from Biocurious follows.

Figure 7.4: The Biocurious Five

1) Counter Culture Labs (CCL) - "Oakland's grassroots community lab for biohacking and citizen science."

2) Berkeley Bio Labs - "Berkeley BioLabs' mission is to accelerate biotech innovation through a collaborative, high throughput approach to scientific discovery and business development."

[88] Which of the two labs - Genspace or Biocurious - opened first has been a topic of conversation at every gathering of DIYbiologists I have attended. The question is unresovable, as it is the stuff myth is made from.

3) IndieBio - "IndieBio is the world's first Synthetic Biology accelerator. At IndieBio, we are devoted to funding and building startups dedicated toward solving humanity's most pressing problems with Life itself."

4) Bio, Tech, and Beyond - "We provide low cost lab space and shared resources that make it easy to start a science company."

5) La Jolla Library - "The La Jolla/Riford Library's Life Science Collaboratory is quite possibly the first biology lab inside a public library anywhere in the world. The facility is part of our Innovation Space that also includes a 3D Printing Lab."

Rather than leading with the Library of Alexandria, drawing a comparison between Fairchild Semiconductor and Biocurious might have been the most apt comparison to be made at volunteer orientation. The alumni who left Biocurious have founded organizations emphasizing an alternate expression of the Biocurious idea. These attempts to replay Biocurious in a new key can never produce exact reproductions. Rather, each is a new production, a variation of the idea of the "garage lab." Two of the alumni labs further the attempt to democratize science, differing from Biocurious in expanding the scientific franchise to new groups, while the other three are variations of Biocurious as startup incubator, differing from Biocurious in taking a share of equity from companies in exchange for higher quality lab space and direct access to venture capitol.

Knowledge Production(s) in and of the "Garage Lab"

The final section addresses how the three dynamics identified in Chapter One played out at Biocurious as the board of Biocurious attempted to "alter the world" by leveraging the "garage lab" to displace and disrupt common sense notions of science. At volunteer orientation, the board of Biocurious declared Biocurious to be a new kind of laboratory, a "garage lab" materialized through a distinct design language which shifted the focus of the laboratory from a site where scientific truths were enunciated to a site where science can be experienced. In a break from sober scientific practice and careful publication, the business of showing Biocurious would be the business of Biocurious - extra-vagrant norms of showbiz, overflowing the bounds of the "garage lab" on the front stage and the thankless work of the back stage volunteers in an effort to symbolically engineer (Bazerman 2002) the conditions through which a "garage lab" can be recognized. Further, the board of Biocurious announced at orientation that scientific elitism would be displaced inside the "garage lab" through adherence to"excellent customer service," under which Biocurious members would be allowed to pursue ideas with little of no scientific rationale, so long as they meet safety protocols. As the ethnography demonstrated, each of these dynamics was a nexus of difficult deliberations (Varenne 2007) at Biocurious.

This dissertation began with a simple question - how did Biocurious go about making itself recognizable as a "garage lab." Previous chapters have empirically addressed how Biocurious made itself recognizable as "a new thing in the world" through a combination of myth making, media manipulation, and business acumen. Previous chapters also discussed who came to Biocurious and what kind of projects they worked on at Biocurious. Biocurious did symbolically engineer (Bazerman 2002) a place within the scientific landscape for a "garage lab." Not the place the board envisioned for Biocurious at volunteer orientation, but a place nonetheless.

Firestein (2012) reminds us that science creates, with every advance, a greater measure of ignorance than knowledge. Paradoxically, though more is known, there is less to be certain of today than yesterday. Our designs on knowledge are, as Flusser (1999) noted of all design, tricks that threaten at every point to turn on their employers. What is true of scientific knowledge production is true of knowledge production(s) more generally. We can say something of knowledge production(s) more generally by drawing a parallel with the "new FBI" discussed in Chapter Six. In changing their focus from ex post policing to ex ante prevention, the "new FBI" creates an expanding number of unknown dangers and therefore, a need for an expanding array of experts and expertise to police new these unknowns.

This brings us to the crux of the paradox at the heart of the effort to democratize science in a "garage lab." Who can determine what is worth knowing? Turner (2003) observes that the ongoing production of knowledge is not in itself adequate to decide the question of what is worth knowing. An intensity of knowledge cannot substitute for the quality of judgment over what knowledge is worth knowing. In Collins and Evans' (2007) typology of expertise, both knowledge creation and the judgment of what knowledge is worth creating is embodied in the contributory expert, who possess technical acumen and wisdom in equal amount. But need this be the case? Can we, as the board of Biocurious argued at orientation, make citizens into scientists?

A remarkable paper (Blackawton 2011) published by a working biologist in conjunction with an elementary school class illustrates that science can be made egalitarian. I learned of the paper when it was sent to me by an academic biologist teaching at Biocurious. It was illustrative, he related, to the spirit of inquiry possible, if not always reached, within DIYbio. In brief, the article describes how a class of elementary students designed a series of novel experiments to test how bees use color and spatial relationships to determine how bees learn which flowers to pollinate. Because academic literature is out of the reach of the 8- to 10-year-old co-authors of the Blackawton (2011) article, they had no access to the history of scientific inquiry, nor knowledge of the social position accorded to scientists. In these matters, the children of Blackawton are ignorant. However, as their adult co-author argues, ignorance of history does not obscure their inquiry nor make it less important, but rather "reveals [science] in its truest (most naive) form, and in this way makes explicit the commonality between art, science and indeed all creative activities." In the Blackawton conception, science is a form of play with rules of inquiry designed to explicate previously unexplored relationships - whether those relationships be well established in the literature or undiscovered.

This is a wonderful sentiment and true in any poetic formulation of science. But there is a limit. As a beaker is not a wine glass, so an elementary school student is not a scientist. There is a social hierarchy at work in both instances, which only becomes visible at what we might term the level of second-order effects. In the immediate present of Blackawton, or at Biocurious when "stupid was OK," it was possible to do science in a naive and poetic sense. But this naive and poetic version of science was both underwritten and foreclosed by the actions of contributory experts at the second-order, the safety expert at Biocurious and the professional scientist at Blackawton respectively. And it is the experts of the second-order who negotiate with the experts at the third-order, FBI agents with PhDs and journal editors respectively, over the fate of the naive and poetic science. The contemporary world is experts all the way down. But which experts? Why, for instance, the FBI?

And here we come to the horns of a related paradox. As Dumont (1980,311-312) noted in an essay on value, effecting egalitarianism on any level comes with a toll. And that toll is the erasure of meaning through the collapse of existing differences. One can think of the many experienced laboratory scientists at Biocurious who were forced, or selected themselves, out of the space during the first two years of operation or of the DIY lab benches and biowaste issues that caused so much consternation as scientific expertise was flattened. We can go a step further and assert that most of the conflicts at Biocurious revolved around the work of erasing existing scientific expertise and creating new forms of expertise. Just what safety means at Biocurious and who can be the safety expert negotiating with the FBI are precisely the stakes of a "garage lab." Dumont offers further insight on this last point. Per Dumont, egalitarianism is first the reduction of alterity to zero. In a second move, egalitarianism forms the grounds for a new hierarchy in which new differences become meaningful. Egalitarianism is not a solution to governance so much as a halfway house between durable political arrangements.

The choices in reconciling these opposed impulses, per Dumont, are escalating conflict or a new hierarchy built on the complexities of etiquette. To Dumont, I would add that these opposing tensions play themselves out in a self-similar manner at every level of DIYbio: at the historic level of arguments over elite or egalitarian control over the tools of genetic engineering at the Asilomar Conference, and to the ensemble formed by the Biocurious Five, to the conflicts between volunteers, members, and board members at Biocurious, to the creation of new elites within "community projects." What we see within DIYbio is the transposition of existing forms of scientific expertise into a new key. The choice will not be between close professional control over genetic engineering or its escape into the hands of wild amateurs, as the Asilomar conference of 1976 declared. A new etiquette for genetic engineering is slowly emerging, one that relies on the logic of economics to determine what to make, the logic of surveillance to determine who can make, and the logic of computation to determine how to make.

Rather than the scientists of Asilomar politely asking their colleagues to police themselves, the "new FBI" serves as the final arbiter of safety. Rather than academic journals and conferences serving as a venue for reporting results, video conferences and email threads carry the load. These changes and their elaborations will define the future of DIYbio and perhaps a widening circle of biology itself, as these idea continue their drift as possibilities to be deliberated over (Varenne 2007). The shackles of elitism have not been thrown off so much as a new elite has emerged with DIYbio.

In no small measure, the new elite emerging within DIYbio is the fruit of the design language operative at Biocurious "affecting the world." When the design of Biocurious was first presented at volunteer orientation, it was shocking and caused many potential volunteers not to return. But, like all cultural productions (Boon 2000,430), the shock of unexpected juxtaposition fades over time. What was radical and inventive about the "garage lab" at Biocurious is old news now. And Silicon Valley, like all of showbiz, demands the constant production of novelty. Today, Biocurious is no longer the “next big thing out of a Silicon Valley garage.” The buzz of interactional experts (Collins and Evans 2007) attempting to tie together disparate domains for profit and knowledge has declined. Biocurious has become an elder statesman of the DIYbio movement, diplomatically representing DIYbio to potential regulators, the "new FBI," and an ongoing stream of innovation tourists from corporate teams and government agencies.

What made Biocurious novel was the design of the “garage lab.” In this sense, Biocurious finds itself in the same position as Flusser's (1999) ubiquitous plastic pen.

> The plastic pen is disposable . . . The only thing that gives plastic pens any value is their design, which is the reason that they write. This design represents a coming together of great ideas, which—being derived from art and science—have cross-fertilized and creatively complemented one another. Yet this is a design we don’t even notice, so such pens tend to be given away free—as advertising, for example. The great ideas behind them are treated with the same contempt as the material and work behind them.)(Flusser 1999,20)

Biocurious was a juxtaposition of science and commerce, egalitarianism and elitism, and liberty and communitarianism all held together by a design language, a branding campaign, and a blue and white color scheme. But the intelligence that first brought together the technical and social assemblages constituting Biocurious as a "garage lab" is no longer visible, submerged under its own ubiquity and myth making. If new labs and projects with DIYbio are talkies, Biocurious remains a silent film.

In closing, the efforts branding Biocurious as "the next big thing out of a Silicon Valley garage" yielded mixed results. The “garage lab” today has a distinctively lived-in look. Yet, for the corporate and government innovation workshop attendees, Biocurious is like Disneyland, with thrill of transforming DNA in Tomorrowland sitting alongside the comforts and nostalgia of a garage on Main Street. Much like the original Hewlett-Packard garage, Biocurious has become a stop for pilgrims on the constantly expanding list of former “new things” in Silicon Valley. Biocurious has been subsumed by the narrative of Silicon Valley with its relentless focus on the prospective future just around the corner. Yet Biocurious is not a passive actor in a narrative arc written by others. Similar to what Johnson (1981,164) has noted of the peculiar power Disneyland holds over the popular imagination of visitors, Biocurious is not a museum but something “actually more powerful than history since its form is concrete, containing ‘real’ people and ‘lifelike’ people with plenty of action and drama by both.” As the board member foretold at orientation, Biocurious is clean, the people are friendly, and workshop attendees receive a consistent experience.

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Appendix One

Folklore of the Modern Laboratory

This appendix examines the folklore of Biocurious through three cases: first, the appearance of the unicorn at Biocurious; second, the writings, in notes and notices, on the walls of Biocurious; and third, through instructional stories told at Biocurious about Silicon Valley, entrepreneurship, and the use of technology.

If the ongoing deliberations (conflicts and agreements in speech and deed) between the members and board over what Biocurious might become can be said to have public consequences, then the folklore of Biocurious can be read as a continuation, via popular means, of these same political conversations. Within anthropology, folklore has traditionally been associated with educative practice and in particular, with the process of sentimental education - how one is to approach one's work.

Folklore is presented here in that vein, primarily as texts which instruct the formation of sentiments. Secondarily, these folklore elements are given in the spirit of Malinowski's (1922) corpus inscriptionum as a presentation of sayings, traditional actions, and collected stories free of excessive theorizing.

Though folklore may seem out of step with contemporary anthropology, consider Dundes and Pratger's (1992) definition and justification for continuing the collection of folklore in the urban context:

> The modern definition of folk as any group whatsoever that shares at least one common factor--language, occupation, religion, ethnicity--makes it possible to consider the folklore of various urban groups. Labor unions, industrial companies, civil rights groups, and hippies are all examples of urban folk groups who have their own special sets of traditions. (Dundes and Pratger 1992,xvii)

The denizens of Biocurious constitute one such group with a special set of traditions. Like any association of people, Biocurious developed its own folklore that served to differentiate old-timers from newcomers, to rally the polity in times of strife, disagreement, and danger, and to instruct those within Biocurious about its history and place within both Silicon Valley and DIYbio. Dundes and Pratger (1992) argue later in their text for the continued relevance of folklore:

> Do machines and advanced technology destroy folklore? We suggest they do not. Rather, technology and its effect upon human life become themselves subjects of modern folklore. Such machines as office copiers facilitate rather than inhibit folklore...Folklore will be around to help humans cope with their problems as long as there are humans and problems! (Dundes and Pratger 1992,221-222)

And as this dissertation has demonstrated, at Biocurious there were many human problems. And here I would stress that employing folklore at Biocurious is also an example of "telling the code" or "talking about machines" (Orr 1996) in that the collection of folklore is not merely descriptive of everyday life at Biocurious; rather, it reflexively constituted life at Biocurious. A selection of folklore from the first years of Biocurious follows.

Seeing the Unicorn

The most important animal at Biocurious was the unicorn. The unicorn was often sighted after a disagreement, like so many at Biocurious, which could not be fully resolved. Why the unicorn? Three distinct uses of the word unicorn came together at Biocurious. First, the unicorn image was a play on the design of Biocurious, which was constructed from parts of other social forms hammered together in an uncertain fit. Second, the unicorn has a special significance within Silicon Valley. A unicorn in the current venture capital lexicon is a startup company which transcends both expectations and market segments. A unicorn has the power to mint multiple billionaires and dozens of millionaires and can only be discovered by a venture capitalist of pure vision. Despite, or perhaps because of, the conflicts at

Biocurious, it was often expressed that Biocurious was itself a unicorn that would transcend expectations and market segments to reshape contemporary life. Around the lab, it was often heard that eventually, if not sooner, there would be a DIYbio laboratory in every neighborhood. And that Biocurious might become a franchise. Finally, the unicorn encapsulates the promise of synthetic biology by indexing the possibility of creating novel forms of life and gaining full control over the drift of biological evolution.

The timing of the unicorn's appearance is telling. In one case, the unicorn appears before the highly contentious laboratory reorganization meeting, organized in the wake of the Google equipment incident, discussed in Chapter Four. Below, a board member complains to a lifetime member over the meeting's agenda and date.

Figure 8.1: "I'm gonna go stare at unicorns for an hour"

Man, come on. Just stop it. I proposed the meeting, I'll set the agenda and the date.

I never said the meeting was on Thurs. That was you, when you tried to correct others - I originally proposed Tues. Look at my post. Maybe you ought to start a separate "complaint" meeting. Seriously. Though you haven't talked to me about it, I'm hearing from others that you have lots of complaints. They won't get addressed if you don't bring them up.

My big complaint: stop trying to take over things I'm in charge of. And quit dancing around it in email. If you want to have a private conversation, we can. If you want argue it in public in real-life, I'll do that. But lay off on the email trolling.

I mean, really. I have more fun emptying the trash and dealing with irate parents than I do messing with stuff like this. I'm gonna go stare at unicorns for an hour. Someone save me...

Picking up on the theme of complaints, this email was one email in a list of emails referring to a spreadsheet containing numbered suggestions about changes to be made at Biocurious. At the time of the email above, there were approximately fifty complaints on a list that would grow to over eighty items. The public existence of the list was an implicit critique of the board's vision, and the ability of regular members and volunteers to add complaints was a public statement about the board's design for Biocurious.

While the conflict over the laboratory reorganization meeting was playing out over the course of an extremely contentious email conversation that included the majority of members, board members, and volunteers, the unicorn made additional appearances. In figure 8.1 the unicorn takes on its most common form, a creature that can be found "farting rainbows." In some tellings, not reproduced here, the unicorn also "poops" rainbows or gold nuggets.

Figure 8.2: New Item

New Item:

... and I opened the back cage only to discover a unicorn farting rainbows. Was anyone expecting this delivery?

The sightings continued as the thread grew ever more contentious. Figure 8.2 makes reference to the list of complaints contained on the public spreadsheet.

Figure 8.3: The Unicorn Has Escaped

> After physical inspection of the cage, I asked around, and the Unicorn has escaped. #54 is closed.
>
> I've added #55 to manage special handling request for incoming special chemicals (freezer not fridge, etc).
>
> Thank you all very much for doing so much stuff!
>
> There are a few items on the list that need an owner - let me know if you want to own any.

Eventually the thread was brought back around to the special tradition being established at Biocurious.

Figure 8.4 The Missing Unicorn

> If the missing unicorn is located, for some reason not in good health...[redacted] said he could dispose of the bones no questions asked regarding the unicorn's condition. Something about a new super adhesive, perhaps to repair the sponsor poster's. he heard unicorn's make the best glue.

A few months later, another contentious issue arose. A reagent vending system had been set up in the wake of the laboratory reorganization meeting. However, many of the reagents were being used without payment, and this was causing a serious problem with experimenting around the lab. In the wake of the missing reagents, it was jokingly suggested via email that DNA fingerprinting could be used to figure out who took the reagents.

Just when the email exchange could have taken a contentious turn, the unicorn appeared.

Figure 8.5: Glo-in-the-Dark Unicorn

I'd like someone to engineer me a glo-in-the-dark unicorn that poos rainbows. That would be super primo. Just thought I'd put it out there since you're asking. I know, most girls say "I want a pony", but that's sooo 20th century.

This was followed by further elaboration of the unicorn idea. In Table 8.5 "glo-in-the-dark plants" is a reference to the emergence of the Glowing Plant project discussed in Chapter Seven.

Figure 8.6: How Science Works

We're working on glo-in-the-dark plants. If you can get your hands on a unicorn, your best bet for now would be to feed the plants to the unicorn. I assume rainbows will ensue - because that's how science works.

Finally, the unicorn was elaborated upon in a comparison to the greatest of futurist cliche, the flying car.

Figure 8.7: Flying Cars and Unicorns

Natural Laws? Oh please! Everyone knows that the deep inner workings of Science are the product of human legislation! ..., what are you thinking?

;-)

No unicorns that I know of. How about several Lipizzaner horses and some narwhal DNA? I've got a blender, We've got PCR's at the lab. How is that we can't make this happen people? It's a Friday night and I'm at home reading up on arabidopsis, different kinds of polymerase, and the CogSci of colors. I'm a humanities graduate, it's not going smoothly. I have this bizarre feeling I should be at an art opening somewhere. Throw me a bone here. If I can't have a flying car, at least give me the prospect of a unicorn.

The unicorn is a creature of both immense hope and disappointment. It further serves as an index to the conflicting ideas present at Biocurious over what Biocurious should become. And in a larger sense, it indexes the limits of science and technology to remake the world or escape history. One may see unicorns at times of trouble, but more often than not they are harbingers of empty promises like flying cars.

Writing on the Garage Walls

Much of the work at Biocurious was aimed at maintaining and repairing the physical infrastructure of the lab. And, the task of maintaining the equipment and relationships fell to the volunteers.

Shapin (1989) wrote about the role of technicians in repairing the equipment in Boyles' laboratory. Yet Shapin's technicians were not technicians in the contemporary sense of specialists employed for a specific purpose. Boyle's "garage lab" required technicians to fix equipment, but as Tom discovered, technical chores went hand-in-hand with domestic chores. An earlier chapter mentioned a few domestic chores, such as cleaning the bathrooms and washing both dishes and labware, around

Biocurious, but the list was by no means comprehensive.

These domestic chores were in addition to the specific laboratory tasks of taking out the biowaste. This resulted in a number of conflicts between members and volunteers. Often volunteers responded to members' inability to do the simplest chores by making signs.

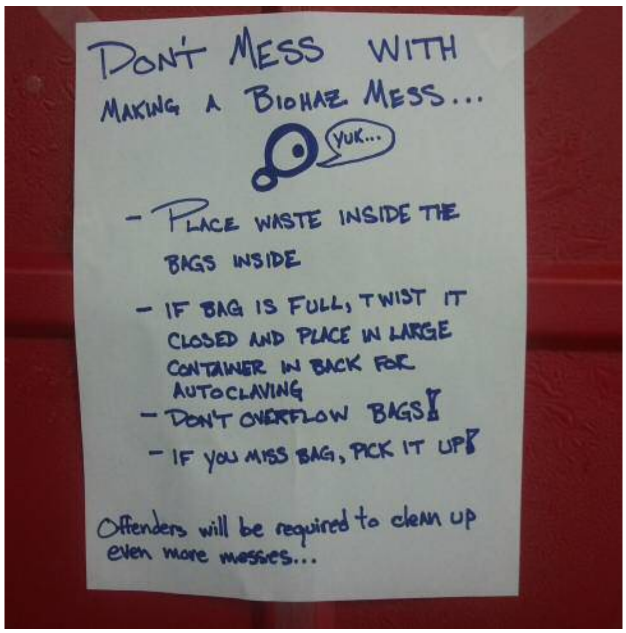

Figure 8.8: Don't Mess with Making a BioMess

The sign in figure 8.8 is typical of the signs often placed on biowaste receptacles. In academic or industrial labs, lab workers would be responsible for ensuring the biowaste was properly disposed. But at Biocurious it often fell to the volunteers to sort biowaste from regular waste or to clean up biowaste which had fallen out of overflowing receptacles. Figure 9.8 is typical of the ad hoc signs at Biocurious in that the Biocurious logo comments diacritically upon the text of the sign. In this case, "yuk."

Figure 8.9: Do I Look Like Your Mother

The sign in figure 8.9 was placed above the refrigerator and snack bar in the classroom area. The Biocurious logo here appears in a gendered form in the most domestic area of Biocurious. The refrigerator in the classroom is expressly not a laboratory refrigerator (despite the laboratory refrigerator literally being a consumer refrigerator). And biological reagents are expressly not food. I have suggested this structural inversion in an earlier chapter, but here, another structural inversion can be suggested. It was widely commented around Biocurious that the gendered Biocurious logo (figure 8.9) resembled the character Betty Rubble from the American cartoon *The Flintstones. The Flintstones* was a cartoon about prehistoric cavemen who lived the technological and social lives of 1950's American suburbanites. Similarly, the social roles inscribed by the volunteer, member, and board member hierarchy at Biocurious served to reinforce that the social distinctions and reified social labor between the domestic world of the classroom and reception area and the dangerous world of the garage would continue into the future.

Figure 8.10 Seat Down!

Figure 8.11: Oh Mysterious Cup

Figures 9.10 and 9.11 are instances of signs and comments appearing in the front bathroom. As was mentioned in an earlier chapter, the back bathroom at Biocurious was largely used for examining experimental results. The front bathroom, on the other hand, was a contentious space from the opening of the lab forward. Recalling Jane's complaint about air fresheners in the bathroom, the signs above serve as reminders of both the gendered work of volunteering where cleaning up after members and visitors was expected and the political stakes of bathroom decor.

As Biocurious came to be more lived in, the graffiti grew more aggressive and took on a jural force as the board was unable to exercise the kind of control of the space that led to the banishment of Jane.

Sentimental Stories

Education and folklore have long history of illuminating one another. Most often, folklore has been taken up as a type of sentimental education (Majasan 1969; Dorson 1962; Brockhouse 1987) and this is how it was deployed at Biocurious. When the tales are told is as important as how. Several of these stories were briefly mentioned in earlier chapters but were abridged or summarized. The following section relates two of the sentimental stories told at Biocurious in their full form.

Napster and iTunes. During the course of a laboratory meeting, a situation developed in which we needed a particular set of biological components to complete a project; yet we had neither the means to fabricate them ourselves nor the proper credentials (this being a DIYbiology laboratory as opposed to an academic or industrial laboratory) to order them from a supplier. There was one option left open to us, however. One of us could, with the help of a friendly accomplice in a nearby academic laboratory, pirate the necessary biological materials and transport them to the laboratory. Normally, obtaining biological materials like this would require a Material Transfer Agreement and some legwork, but our contact in the academic laboratory was willing to clone the part repository for us after hours at their lab. Following that, a project member would bring the parts to the "garage lab." This requires pirating the material with all the attendant illegality.

At this juncture, one laboratory member, Kenneth, recounted the story of Napster and iTunes. This was a story well known to Kenneth, who made a successful exit from a startup company he founded in the same period and was attracted to DIYbio by the possibility of creating a new industry. Without the invention of Napster, he said, there would have been no impetus to develop iTunes. The music industry needed the entrepreneurs behind

Napster to instruct it about digital music and iTunes was the educated reaction. The music industry needed Napster to change the rules of the music industry. He noted that the same phenomenon was at work in the early days of YouTube when most of its content was illegal. That illegality teaches a lesson is the way of the disruptive economy. In this telling, we would be doing industry and regulators a favor by pirating the biological parts we need and using them to build our project, a glowing sign. The landscape of biological inquiry was changing and the old rules for transferring biological materials were not keeping abreast of the changes. In fact, our piracy would be the necessary impetus for regulatory agencies and large corporate actors to step in and issue rules that everyone can abide by.

In establishing a new rule, judged valid by our own authority (our self-claimed expertise) and position, we would be positing a speculative new arrangement (a game) for transferring biological material. We would be instructing those who would regulate or enter the new arrangement, that is changing the rules of play, in what was now possible. The game was already rigged but we could make the rigging publically viewable. Taking this step, Kenneth argued, was part of the fun and excitement of constructing an industry in a grey area of the law.

HD Controllers and Clean Floors. In the early summer of 2012, I worked on a project titled The Bay Area Dandelion Project (henceforth BADP) along with a fellow volunteer. This was a citizen science project designed to address a basic problem in dandelion speciation - are there 20 species of dandelions in the Bay Area? Or 2,000 species? The BADP planned to address this question on two levels: first, through the collection of dandelion leaves using morphometric analysis to examine form based speciation, and second, by conducting a DNA based experiment using microsatellites to examine genetic based speciation.

One summer day, as we were working out the details of our DNA extraction and amplification protocols in the empty lab, our DNA sample failed to show up on the transluminator. That was the culmination of many problems we suffered that day. The gel box we selected leaked, so we had to revert to a DIY gel box that turned out to have a broken wire. On top of that, we were at one of the DIY lab benches and the top sagged in the middle, thus rendering accurate measurement next to impossible. And earlier in the day, we likely left our temperature sensitive reagents at room temperature for too long, thus dulling their effectiveness. By any accounting, our experiment was a failure, and our attempts to figure out why we failed were running into a wall of unaccounted variables.

While we were working, Tom came into the lab and sat down to watch us work. As we were cursing our troubles, Tom told us a story about working on the team that developed the first HD controller for the IBM PC. He recounted the way Bill Gates made a deal with IBM without having the deliverables in place and how IBM management broke their rules and deviated from their 5-year in-house development plan to license technology out to other companies. I pointed out that this made Microsoft, and he countered with the story of Bill Gates lying to IBM executives about his disk operating system. He did not have one, Tom argued, but found one to buy and license to IBM. He also pointed out that the IBM team developed the HD controller in 18 months, something that normally would have taken 5 years. The lesson for us was that not having the correct equipment could be taken as a spur to increased action or as an excuse for failure. Inventing the future is not for the faint of heart or those who quit easily.

At this point, we began to complain about contamination from a source we could not pin down. Our suspicion, like those of most whose experiments fail, was that the DIY lab benches were harboring contaminates that we could not root out. While we were cursing this speculative source of bad luck, Tom related another story. When Texas Instruments was preparing to manufacture the first integrated circuit, the engineers ran into unexpected difficulties. Seemingly at random, the chips would fail. Circuits well characterized in the development problem suddenly went feral and refused to perform within their known parameters. After several months of isolating problems in the manufacturing process, a visitor pointed out that some engineers entering the building were walking across the periodically fertilized lawn instead of using the sidewalk and contaminating the processing plant. Once this problem was discovered and a workaround in the form of plastic foot coverings introduced, the integrated circuit business took off.

Taken together, these three stories, one from Kenneth and two from Tom, serve as instructions into the sentiments of the engineers and entrepreneurs who constructed previous industries on the back of wild and feral technology. They say something about the centrality of Silicon Valley and the gravitational pull of "the next big thing out of a Silicon Valley garage." In the course of ordinary life in the lab, one could often hear sentimental stories directly from participants in the major technological revolutions of the last forty years. More than a concentration of technical expertise, what marks Silicon Valley as a unicorn is the sentimental education available to those who inhabit its concrete and metaphorical garages.

Appendix Two

Modeling Feral Mis-takes

Broadly stated, the question addressed by this dissertation is how do small pockets of order, such as a handful of people in a "garage lab," come to have outsized effects in the world. The ethnographic chapters have gone some distance in demonstrating how Biocurious transformed from a pair of people in an Arizona warehouse into an institution the White House and FBI must take into account, but a more vexing question remains. How do the ensemble of DIYbio laboratories relate to one another and to their academic and industrial counterparts?

This is a more challenging question than the question addressed earlier and demands a different kind of answer. The ethnography in this dissertation is, like most ethnographic work, addressed to what might be called first-order effects of directly producing Biocurious. This appendix wrestles with second and third-order effects by attempting to form a mechanical model capable of accounting for the complex, nonlinear diffusion of "new things," such as a "garage lab" through the world.

Before getting underway, let me pause to clear up a few terms. Second- and third-order effects modulate the unit of interest from the particular, Bicurious, to the level of system or ensemble (Lévi-Strauss 1990). In the introduction to this dissertation, I explained my decision to study Biocurious rather than Genspace. Together with the handful of other DIYbio labs spread around the globe, Biocurious and Genspace could be said to have formed an ensemble. The FBI/DIYbio conference described in Chapter Six illustrates how the ensemble of DIYbio laboratories created in the years in between my entrance to Biocurious and the 2012 FBI/DIYbio conference had expanded. By second-order effect I point to the simple, but complex, phenomena of the consequences having consequences of their own. Concrete examples of this phenomenon are described in Chapters Four and Seven. One consequence of the ongoing conflict between membership and the board of Biocurious was the creation of five new DIYbio laboratories by Biocurious alumni. A further consequence, that we might call a third-order effect is that new DIYbio labs, unforseen in 2011, have overtaken Biocurious as "the next big thing." Looking forward from the September day in 2011 when Biocurious opened the doors of its "garage lab" and I sat for the first volunteer shift, it seemed impossible that the "new thing" then opening would give way so quickly.

How might we begin to understand and account for these unexpected transformations?

I will start with Genevieve Bell's (2010) observations on the unexpected lives of animals imported to Australia under the auspices of improving the Australian economy. In a 2010 talk at Xerox PARC on the spread of computational technology over the last five decades, Bell reached to the Australian outback for a metaphor. In America and England, Bell wryly observes, animals are of two types - wild or tame. But in Australia animals are of three types - wild, tame, and feral. Bell considers the long history of introducing non-native species to Australia, ranging from the Scotch thistle to the dromedary camel, as entrepreneurial schemes for improving economic life in Australia. She finds that these schemes never come off quite as intended. Each improvement is accompanied by a comedic set of unintended consequences, as the introduced species inevitably escape their importer's designs to domesticity and find a new life as feral animals in the uninhabited Outback. Even humanity's oldest and most familiar domesticated animal, the dog, becomes estranged from our understanding when it escapes the bounds of domesticity. To see a feral dog living in the Outback is to see it through a funhouse mirror - recognizable in outline yet distorted in detail.

In both Australia, with its long history of animals moving across boundaries, or in Moscow where packs of formerly domesticated dogs have learned to ride the subway system, something consequential, yet unpredictable, occurs when the boundary between domesticated and feral is passed through.

In the life of feral animals, Bell argues, lies the key to understanding the diffusion of technology. The same movement from wild to tame to feral true of animals imported into Australia is true of technology. Born wild in an engineering lab or field site and domesticated in the form of commercial appliances, yesterday's domesticated technology comes to take on a new life when it moves out of the domesticated sphere of the house to the metaphoric outback of a garage or shed.

In an article discussing the feral afterlives of technology, Bell and Dourish (2007) argue that away from the instructions of engineers and technologists in sheds and garages, domesticated technology is often recombined in unexpected and expressly dangerous directions. The garage is a place where a designer's intentions, whether they may be the design of a scientific laboratory or computing machinery, can be ignored without sanction. Bell and Dourish note that many of the words contemporary associated with the shed or garage within the English language derive from older words associated with dark spaces, male spaces, and the storage of weapons. Appearing at once familiar and strange, both feral animals and yesterday's technology are transformed in the privacy of an outback or a garage to become uncanny (Freud [1919]2003) representations of the tame world.

From Mis-take to Mechanical Model

An exposition of wild, tame, and feral in a different key can be discerned in a close analysis of a Thelonious Monk recording session (Klemp et al. 2008). This work demonstrates that what might appear at first to be a mistake in the case of a musical performance comes to be contextualized in the course of later performances. A note out of place (when heard) in the course of a performance, like all new knowledge, is troublesome. A misplayed note immediately raises a question: Is the note a mistake to be corrected, noise to be ignored, or a suggestion to be incorporated in later performances? Such a note is not wild; it occurs within a defined genre, nor is it completely tame and expected. We might call the misplayed note feral by virtue of being a tamed note voiced in a wild place. The note carries an ambiguity and possibility that cannot be resolved until a later performance.

To come full circle, a misplayed note fits Lévi-Strauss' exposition of the old verb "bricoler." Like a hunting dog moving off the scent or a billiard ball tracing a funny path, a misplayed note is unexpected, new, and problematic. The note cannot be undone or unheard once voiced, nor can the music be stopped and reverted to a prior point. The note is, as Serres observed of the parasite (1982), an opening for an alternate ordering. What the mis-take becomes depends entirely on its relationship both to notes voiced in the past and future notes yet to be voiced.

Towards the end of a meandering career in anthropology, Conrad Arensberg (1972, 1981) attempted to reconcile the then-brewing crisis of representation in anthropology with the scientific instinct of his own graduate training. Arensberg put forth a formal model with which he took up the problem of accounting for the minimal units necessary for an analysis to be considered anthropological. For psychology, Arensberg argued, only the mind of an individual must be taken into account. For a sociological analysis, two positions must be taken into account. Arensberg then argued that for an anthropological analysis to be developed, three positions must be present: two to interact and a third to interpret their actions. That is, any anthropological analysis must take into account the fully social categories through which humans think, interact, and dream. Three positions are also required to account for the creation and dissemination of new knowledge, which Arensberg posits is the inescapable result of social action. I would add that it requires a minimum of three positions (though more may be involved) to explain how knowledge moves from wild to tame and drifts into feralness.

Arensberg's minimal sequence model is a mechanical model in the vein of the models Lévi-Strauss (1966) argued were most suitable for anthropology. Unlike statistical models that posit an array of discrete entities frozen in eternal repose until animated by probability, within mechanical models, humans are situated in the temporal flow of time and animated through the ongoing transformation of relationships.

As Arensberg (1972,20) writes, the power of a processual or mechanical model lies in its ability to account for "a new thing, or state." Arensberg (1972,21) argues poetically of mechanical models: "there is a real structuration to 'cognize,' as real as a cloud, a dance, a melody, a hurricane, a harvest, or a winter . . . if they play out their forms they will bear their fruits." One does not, because one cannot, measure the intensity of a cloud's essential cloudiness. Rather, the goal is to understand the complex relationships inherent in any social phenomenon. Note also that the temporal mode is cyclical and rhythmic. In an important sense, a mechanical model models the drift of form as it diffuses and transforms.

Arensberg revisited his 1972 example in his 1980 American Anthropological Association presidential address published in 1981. Using an example of scapulimancy drawn from Moore (1957), Arensberg builds an interactional model of the process whereby a shaman guides a group of hunters to game. Arensberg (1982,572) writes of the interaction between hunter and shaman:

> The sanction on this drama of decisive collective action is simple. If they fail to find game, they desert him or spear him in anger-or both. The coaction ceases. The gain is clear: a pooling of information and a randomization into new, shared, decisive action which may be successful and is certainly time-and-effort saving and information pooling beyond individual foraging.

Arensberg's interest is in the evolution and development of what is called "coaction" in the quote above. Here I must part ways with Arensberg. Notice that by appealing to pooling and randomization, Arensberg is subtly drawing from the tenants of information theory. Arensberg's quote leads to a statistical model built on the back of the randomly discovering effective action by increasing the number of attempts. He posits communication ("the pooling of information") as a reified (shared) substrate across which human action may be smoothly converted into action. In contrasting coaction to conflict, Arensberg gives us a theory of culture, in the form of communication, as something to be learned and lived out. But consider what happens when the shaman fails the hunters.

We can observe that the final modulation over the shaman's instructions does not belong to the shaman, but to the hunters. The hunters are instructed by the shaman, yet exercise judgment over the shaman's instructions in the form of accepting, rejecting, or ferally interpreting the shaman's injunctions. In their power to refuse instruction, Arensberg notes that the hunters may abandon or kill the shaman. At this point, Arensberg contrasts refusal negatively against the gain to be had in cooperation, arguing for a progressive vision of expanding human cooperation, leading to new shared and decisive action, operating via increase in the intensity of interactions.

Finally, we can notice that in Arensberg's model, as well as in Monk's mis-takes, the effects of interaction are not only felt immediately by the parties present, as first-order effects, but reverberate out in a widening radius. First-order effects also have effects, what we might call second-order effects, and the second-order effects engender third-order effects, and so on.[89] And at each level, the effects of human action are subject to

[89] An explicit conception of second- and third-order effects is curiously absent from most anthropological theory, even though the unintended consequences of second-order effects were formalized in sociology by Merton (1936).

acceptance, rejection, or being judged feral.

Wild, Tame, and Feral Models Cooked Two Ways

Postulating a small pocket of order growing to entail ramifying consequences requires a peculiar type of model that accounts for chaotic and nonlinear growth. The previous sections argued that disciplinary coherence can be discerned around models of this type. The remainder of this chapter will formulate such a model of the wild, tame, and feral effects of new knowledge.

At this point, we have the prerequisites to create a nonlinear model capable of accounting for the drift, sometimes subtle and other times explosive, caused by the inevitable creation of feral mis-taking. Minding that any model must account for both bricoleurs who "interrogates all the heterogeneous objects of which his treasury is composed" and in so doing, invents new centers with materials ready-at-hand, and engineers who "go beyond the constraints imposed by a particular state of civilization" (Lévi-Strauss 1966,19) to invent new ends through the creation of novel technical means.[90]

[90] I use both bricoleur and engineer to indicate two idealized types of action.

Reheating the Culinary Triangle

Though more often invoked than used analytically, Lévi-Strauss' culinary triangle can serve as a starting point for the formulation of a model. In its full formulation, the culinary triangle has the following parts.

Figure 9.1: The Culinary Triangle

Normal	Nature	---------->	Culture
		Raw	
Transformed	Cooked		Rotten

The logic is familiar. Food can exist in three states: raw, cooked, or rotted. The raw belongs to nature and the normal. The cooked and the rotted are transformations of the raw, with the cooked belonging to culture and the raw to nature. This model can be put to use in understanding the process of transformation as follows.

Figure 9.2: The Inventive Triangle

Cismechanical	Given	-------->	Made
		Wild	
Transmechanical	Tame		Feral

I have made a few minor changes. First, I have substituted the given and the made for nature and culture. Second, I have adopted Flusser's (1999) term transmechanical. Flusser intended that mechanical acts stretch across intellectual and mechanical boundaries. An arm acts as a lever, which yields the concept leverage. To recognize the opposite action, I offer the coinage cismechanical to indicate mechanical acts that are self-contained. This is, strictly speaking, impossible, but is useful for illustration.

Lévi-Strauss noted that the culinary triangle is an abstract form for examining concrete connections. By placing empirical cooking strictures within the triangle, the triangle can be used as a transmechanical tool for understanding previously unseen connections. We can do this for Biocurious.

Figure 9.3: The Biological Triangle

Cismechanical	Given ------> Made	
	Biology	
Transmechanical	Salk Lab	Biocurious

The tame Salk Lab described by Latour and Woolgar (1979) can be contrasted with Biocurious, a feral version of the Salk Lab, and both can be contrasted with biology in the wild. This is one way to understand Biocurious, but is limited in an important regard. The culinary triangle works in relation to intragroup relations. It carries the power to make previously unseen relationships visible and can help us draw novel inferences within groups. For example, today Biocurious is a tame version of DIYbio and a yet-to-be-cast iteration of DIYbio occupies the feral position. But the culinary triangle, being oriented towards the internal structure of one society, is of limited utility when trying to understand multiple transformations across boundaries, what we might call second- and third-order effects. To account for these unexpected effects, we must turn, like Arensberg and Klemp, to more ephemeral phenomena like clouds, music, and myth.

Reworking the Canonical Formula

Unlike the culinary triangle, clouds, music, and myth have a distinct temporal element. Each unfolds across time and through space. When a cloud forms, a story is recounted, or a note voiced, it is an event about which something must be done. And this something, and the second- and third-order effects the event engenders, is woven into a narrative structure.

In the short period between the initial formation of DIYbio labs in the garages and kitchens of Boston, New York, Mountain View, Berlin, Paris, and Yogyakarta and the 2012 FBI/DIYbio conference, DIYbio had mushroomed into a movement with ramifying second- and third-order effects. The interest of the national security apparatus in the potential dangers of DIYbio, the loose networks of academic discontents and entrepreneurs assembled around DIYbio, and the consistent media presence all attest to the presence of unforeseen second- and third-order effects engendered by the flapping of a few petri dishes.

At this point, a return to Lévi-Strauss will prove helpful. Towards the end of his long career (and notably in the middle of the crisis in anthropology), Lévi-Strauss broached the problem of transformation across boundaries by reworking the canonical formula he first introduced in 1955. The canonical formula is an approach to the formalization of metaphor. For Lévi-Strauss (1996,194), metaphor is an intellectual move (we might also call it a transmechanical move), which effects two actions. First, it transforms a local viewpoint into a more globalized viewpoint, thus creating the measure of distance necessary for a comparative perspective to emerge. Second, it synthesizes and connects domains that are subdivided and isolated by analytic thought. Lévi-Strauss originally formulated the canonical formula (1963[1955]) to explicate intertwined ensembles of myths and their variants and answer the question of how the myths of neighboring and distal peoples are related across time and space. The comparison here is not made at the level of like cases, a bundle of essential qualities glossed as comparable, but rather at the level of relations (whose discrete essentialisms need not be alike) and their transformations. Thus, the relationships between like events can be rendered visible even when they stem from unlike causes.[91]

Figure 9.4: The Canonical Formula

Fx(a) : Fy(b) ~ Fx(b) : Fa-1 (y)

[91] Gow (2014) speculates that Lévi-Strauss developed the canonical formula to solve a particular difficulty within cultural anthropology. The Achilles' heel of all cultural analysis lies in the difficulty of determining the boundaries of inquiry. Culture is, to be overly sympathetic, subject to the paradox of the heap. For social anthropology the problem is straightforward; language and kinship form durable thresholds which naturally bound inquiry. One solution has been a turn to controlled comparison. But controlled comparison is still a method of comparing like entities. With the canonical formula, Gow (2014) argues that Lévi-Strauss points to another way forward. Through the ensemble (system), Lévi-Strauss elegantly patches the controlled comparison kludge and formalizes cultural analysis through close attention to transformation at boundaries. The result is a cultural analysis at the level of self-similar, nonlinear system.

Per Lévi-Strauss, the twist in the last term that accounts for the transformation of myths as the myth crosses a linguistic, social, or cultural threshold. More recently, Mosko (1991; see also Maranda 2001) has developed a version of the canonical formula to compare non-mythic material. Mosko's variation takes metaphor, rather than myth, as the grounds for transformation. I offer a version of the canonical formula in that spirit, taking the wild, tame, feral metaphor as the grounds for transformation.

Figure 9.5: The Feral Twist

W -> T::T -> F(W)

Here the final term, feral, provides the twist that transforms the previously tamed element as a threshold is approached. The logic runs from wild to tame, then from tame to feral. Feral, in this use, is an elaboration on wild.

Yet the starting and ending points can never be identical; we need not assume that like starting points lead to like ending points. A feral animal is not a wild animal. It is a tame animal left to its own devices, a de-cultured invention or an unresolved mis-take. As an example, we can consider climate change in terms of this model. The weather was once wild and uncontrolled, but through the development and application of meteorology, weather was rendered, if not controllable, understandable at least.

Today, climate change has altered weather patterns in such a way that the weather is no longer understandable; meteorology has reached its limit and the weather has become feral. Our previous understanding of the weather is of little help at this historical moment. New knowledge, with its attendant troubles, will have to be produced and new disciplines will have to emerge.

The labs formed by Biocurious alumni, discussed in Chapter Seven, constitute feral mis-takes, which take missed notes (Klemp et al. 2008) at Biocurious as their starting point for new compositions on the theme “garage lab.” We might model the differences and resemblances between the multiple DIYbio laboratories created by Biocurious alumni as a three-bodied process of wild, tame, and feral knowledge.

Figure 9.6: From Biocurious to Counter Culture

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"Garage lab" -> Biocurious::Biocurious -> Counter Culture Labs("Garage lab")
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If Biocurious is emblematic of the garage in Silicon Valley, then Counter Culture Labs, one of the labs founded by Biocurious alumni is a garage of a different sort: a garage directed away from corporate aspirations to incubate the new technology that will usher in the next profitable market and towards viewing the garage as a space where individuals can tinker with biology without preconceived ends or externally imposed limits. Each of the Biocurious Five, taken individually, can be understood as an elaboration upon the “garage lab” idea. Taken as a set, it is the differences between the six DIYbio laboratories that give form to their resemblance. A "garage lab" is a wild (in being untamed) idea, but it is not an idea without boundaries or limiting conditions. There is a system of constraints and boundaries (differences) apparent when the ensemble is viewed from a more global perspective.

In the introduction, I gave a brief explanation of the systematic differences between Biocurious and Genspace that led me to Biocurious. Then in Chapter Two, I examined the system of differences between the DIYbio codes of ethics operative in North America and Europe respectively. Going a step beyond, we can say that the matched pair, Genspace and Biocurious, constitute an ensemble. Likewise, the Biocurious Five constitute a larger and more specific ensemble, and the system of differences between the American and European code of ethics, yet another. If we are willing to take another step outward to the perspective afforded by the FBI/DIYbio conference, we can see that DIYbio laboratories form a worldwide ensemble, being related in their difference to academic and industry laboratories and their more specific differences to one another. In this sense, DIYbio laboratories can be related to petri dishes where ideas about governance, education, and science can be cultivated and elaborated upon. In other ways, they are spaces where stupid might be okay and conventional ideas about how to organize science can be ignored while new forms of organization are worked through.