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Comment

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Outlaw, hackers, victorian amateurs: diagnosing public participation in the life sciences today

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ABSTRACT: This essay reflects on three figures that can be used to make sense of the changing nature of public participation in the life sciences today: outlaws, hackers and Victorian gentlemen. Occasioned by a symposium held at UCLA (Outlaw Biology: Public Participation in the Age of Big Bio), the essay introduces several different modes of participation (DIY Bio, Bio Art, At home clinical genetics, patient advocacy and others) and makes three points: 1) that public participation is first a problem of legitimacy, not legality or safety; 2) that public participation is itself enabled by and thrives on the infrastructure of mainstream biology; and 3) that we need a new set of concepts (other than inside/outside) for describing the nature of public participation in biological research and innovation today.

In January of 2010, UCLA's Center for Society and Genetics ran a symposium entitled "Outlaw Biology: Public Participation in the Age of Big Bio." The goal of the symposium was twofold. First to investigate the question of what public participation in the life sciences means today, after the completion of the Human Genome Project and second, to facilitate that participation by inviting people to workshops, discussions and exhibitions that followed the discussions. The event was a huge success, bringing together quite diverse approaches to the problem, and raising a range of questions about the legitimacy, danger, enthusiasm and weirdness of different kinds of participation in the life sciences—from lab work in prestigious venues, to art projects, to DIY biology. This is a revised version of the essay that introduced the event.[1]

Outlaws, hackers, victorian gentlemen

Sometimes it helps to have a figure to work with in order to understand how our world is changing. Terms like "the public" and "mainstream science" mean very little to most people, but thinking with figures whose features bring out some aspects and hide others can be a much more revealing enterprise. Here are three: outlaws, hackers and Victorian gentleman scientists. All reveal different features of what's happening to public participation in the life sciences today.

Outlaws fall outside the system — they are glad to be like Robin Hood, unaccountable but connected, poaching resources and distributing them to people who could never imagine having them. Outlaw biologists love de-mystifying science: 'did you know you can extract DNA from strawberries using simple household products!? Anyone can do it, you don't need permission from Science.' The Outlaw's motivation is delight, especially delight for those who might not otherwise have access to it. Outlaws can exist inside as well as outside of science. These are the gadfly scientists, the kooks, those with the slightly nutty ideas. They live not so much at the frontiers of science (that's where everyone wants to be), but beyond them, in no man's land. Their innovations have yet to be recognized by Big Bio — they may never be.

Hackers, by contrast, reconfigure the system from within. Hackers are not — despite the way they are most commonly portrayed — outlaw libertarians, but rather tinkerer liberals. The distinction is important: outlaws live alone but hackers live together. The pleasure of hacking comes from impressing others by understanding a system well enough to control it and to make it do something it wasn't meant

to do, not just de-mystify it. Bio-Hackers properly speaking wouldn't care at all about getting DNA from strawberries. Rather they would be interested in engineering a strain of strawberry cheaply, cleverly, and to the delight of their friends. Maybe it's a purple strawberry, or a strawberry that smells like a banana. Or maybe it's a dangerous virus-transmitting strawberry, but in that case the hack is intended to show how easy it is to do, and how we might need safeguards beyond that of morals and good will. The hacker's innovation is a re-configuration, and it is one that values openness, transparency and modifiability. The Hacker's innovation has little to do with what counts as innovation in Big Bio, but it is no less innovative for that, and it often impresses — and frightens — the elites.

Finally, the Victorian Gentleman Scientist is neither outside nor within the system, but above it. His view on things is that of the aesthete and the discriminating intellectual. He shares with the outlaw and the hacker an appreciation for openness, transparency and a bit of magical delight, but with it comes a bit of paternalism, a bit of the hoary, learned wisdom of the well-born and justifiably eccentric. Victorian Gentlemen know everything there is to know about strawberries, and DNA to boot. They have a circle of friends with access to the best tools and techniques, and a coterie of willing participants in their schemes. Artists are more likely to be Victorian Gentleman than hackers and outlaws (though they may desire otherwise), and find extracting DNA from strawberries to be useful primarily in a critical re-configuration of the tradition of the Still Life. The Victorian Gentleman's innovation is the innovation of Big Bio in miniature, but projected on a big screen and tuned to different purposes, critical purposes and renewals of energy and focus. On occasion, it impresses everyone.

A fourth and even more provocative figure emerged from symposium discussion (provided by sociologist Ruha Benjamin and prompted by snippets of *The Outlaw Josey Wales* playing in the background): the Buffalo Soldier. Buffalo Soldiers are the inverse of the Outlaws of the 19th century — outsiders conscripted into the system and made safe by subjection to fierce and unrelenting discipline. Buffalo Soldiers represent an antidote to the cheerful individualism and enthusiastic self-making of the hacker and the outlaw (though they may share discipline and constraint of a certain sort with Victorian gentlemen). Buffalo Soldiers, we might presume, come for the strawberries, but stay for the DNA. Roger Brent suggested a connection to the cosmopolitanism of global science, which allows in its own way, radical cultural difference to be controlled and disciplined within the space of scientific interchange — and the ambivalence of the buffalo soldier with overtones of both patriotism and assimilation. The figure of the Buffalo Soldier reveals the privilege that inheres in outlaws and outsiders today, those who can afford to adopt an outsider status; those who can want to reap the benefits of cultural cool[2], but also can afford to risk the quasi-legitimacy of standing apart from the troops in biology.

All these figures feature in the landscape of public participation today, and it perhaps by thinking through them, and the differences they might represent, that we make progress — in this symposium and elsewhere — in understanding what's happing to biology today. In some ways these figures are versions of a question about "how we live today" addressed by panelist Gaymon Bennett, and invoking classic problems of science as a vocation, a calling, a job, or a career.[345]

Thinking through these figures tells us not only about the people involved but the science and its place in public culture as well. This essay touches on three related issues: the first is that outlaw biology (and hacker and Victorian biology) is not simply illegal or criminal, but *before* the law, outside it, engaged in problems with which the law, and our understandings of what is right and wrong, have not yet become routine or recognizable. The second is that paradoxically perhaps, outlaw biology is not outside of Big Bio but within it — it depends on it, thrives on it, and wouldn't exist without it. And the third, following on these two is that understanding — or encouraging — public participation in science today requires us to move beyond a simplistic model of inside and outside, and perhaps develop a new language and new way of describing science-making and innovation today.

An outlaw biology?

The Outlaw Biology symposium started with a focus on the much-hyped DIY (do-it-yourself) Biology "movement." Two participants came as enthusiastic supporters of DIY Bio. Jason Bobe helped found the movement with a handful of others, and his project "bioweathermap.org" teaches people to understand the ebb and flow of microorganisms present in the environment. Volunteers collect swabs from various public places and use donated time on cutting edge genetic sequencing tools to identify and then map them. Meredith

Patterson caught a wave of media attention to DIY Bio when she proposed to engineer a bacterium to sense melamine in food, and got some of the way toward succeeding in her at home laboratory.[6]

There are by know a couple of dozen mass media portraits of DIY Bio (see for example Bennett et al. 2009[7]) and at least as many journalists, anthropologists, venture capitalists and FBI agents swarming around looking for the meat. Whenever a media-frenzy happens, there are bound to be responses, backlashes, dismissals, and unwarranted promises. DIY Bio has all these things going for it, or against it, right now. Pick up any report about DIY Bio and you will see the same story repeated over and over again — it's a very American story. It goes like this: on the one hand these amateur biologists are setting up labs in garages and are creating the next silicon valley; they are Bill Gates and Steve Wozniak in the mid-1970s, just before the PC explosion, but this time in biology. On the other hand, they are screwing with living organisms and if they aren't careful, we will all die from the virulent bugs they create but cannot control. It's either an economic miracle waiting to happen or an apocalypse around the corner.

Jason and Meredith's projects are very real and they suffer from successes and setbacks like any project. But the image of hackers in garages synthesizing the biological equivalent of Microsoft DOS (shudder) out of Elmer's glue, yogurt and a wad of DNA fragments is nothing more than an aggradizing myth. Myths have their use (any anthropologist will tell you) but they also stylize and abstract the facts rather than state them clearly. Fact is, we live in an awesomely complex and tangled bank of markets, networks and technologies that enable not just a messy and currently incoherent DIY biology, but *also* elite science in the labs and fields of Big Bio as well. Whatever the conditions that make DIY possible — they are the same conditions that make Big Bio work.

Calling a symposium "Outlaw Biology" looks like it participates in just this kind of myth-making. But sometimes it's necessary to think through myths in order to argue with them. Calling public participation in biology "do it yourself" has a nice, crafty, slightly punk sound to it. Calling it "outlaw biology," by contrast, creates a lot of anxiety, though it is not entirely clear why. One possible reason for the anxiety might be the power life has to creep us out by replicating and proliferating and growing beyond our control — and the related power we now have to bend life to our unnatural wills (that apocalypse narrative again). But another answer might be easier: the anxiety provoked by an outlaw biology has less to do with biology or engineering *per se*, and much more to do with the institutional configuration of scientific and technical research today — with what it means to *do science* today. Who is a real scientist today and what does that mean? What "form of life" do scientists themselves live out? Who sets the agenda? Who gets to innovate and tinker with what and who gets to regulate and oversee that activity?

There have been some enormous changes in the political economy of innovation and research in the 20th century. We've gone from a post-industrial economy organized around big, hierarchical corporations that had informal but powerful ties with big but sparsely policed Universities, to a world of small start-ups and fluid venture capital, huge collaborative efforts to pursue an "industrial biology" and vastly increased federal power to influence, control and even prohibit research. We've gone from an era of very small communities of biologists that regulated themselves and called their own moratoria (Asilomar) to federal laws that prohibit human cloning and restrict research on certain kinds of cells. Today a young biologist is confronted by a heterogeneous scramble of basic biology, commercially-driven research, patent lawyers, bio-ethicists, software engineers and impresarios creating more tests than anyone can interpret, more drugs than anyone needs and more promises than anyone can fulfill. Many biologists entered the field hoping to find those small communities and cottage industries, to contribute to basic biological science, and to solve some pressing problems — and not to mess with patent lawyers or work on tests and drugs that didn't seem necessary. A lot of people got into the business to do good, not just to do business. But everyone wants a piece of the life sciences, and that has transformed the institutions of science and engineering.

An anxiety about outlaws isn't the same as an anxiety about criminals. Outlaws are outside the law, or before it, and this is why questions of regulation, oversight, self-governance and the technical infrastructures necessary to achieve any of those crop up immediately in media reports on DIY Bio, and the few ethical analyses appearing; they inevitably raise the questions of federal regulation, bio-hacking and bio-terrorism.[8] Safe biology is implicitly one regulated by the state and the legitimate organizations of science, and so an unregulated biology is an outlaw biology. This makes DIY Chemistry, or "clandestine chemistry" (where individuals synthesize illegal and legal drugs using federally regulated chemical pre-cursors) simply *criminal* biology, not outlaw biology. Of course, there being no shortage of regulations in the US, much of what counts as DIY biology is implicitly regulated in some form or

another already. As much as outlawry evokes images of total freedom, an outlaw biology operates within a maddeningly complex tangle of codes and regulations intended for all manner of purposes. Posing the figure of the outlaw should help us see that there is no true wild west, only a (classically American) nostalgia for unregulated and open spaces.

Beyond the question of law, the Outlaw is also a figure that evokes a certain kind of populism as well, whether that's the relatively benign populism of a Robin Hood, or the murderous populism of Josey Wales or John Dillinger. Outlaws are people who critique the system through action, who care about the little guy and who fight for the rights of those they perceive to be exploited. But they aren't citizens either: Josey Wales was a confederate supporter; Robin Hood, in some versions, a dispossessed nobleman. Being outside the law in this sense does not mean breaking the law, it means falling outside it completely. The important aspect of being beyond the law is that it leaves the outlaw with only an irrepressible sense of moral duty, a righteousness beyond that of any legitimate community. Some in DIY Bio clearly see themselves in this populist light — for instance, Meredith Patterson launched a "BioPunk Manifesto" at the symposium, which was written partially in these terms, and ends with an invitation to join the biopunks in their outlaw spaces.

Outlaws are also cool. They are the ultimate individualists — they take matters into their own hands and train themselves up to deal with a harsh, uncaring, bureaucratized world that cannot understand them — and they do so with style, cleverness and a sense of belonging to the future. They are the gadflies and jesters who dissent from an imaginary oppressive regime, usually associated with government or large organizations, but always with the rule of law, to demonstrate the creative power of the individual to make his own freedom by sticking to the categorical imperative against all that pressure to abandon it for the pragmatism of living with others. Outlaw biologists make science cool, which is good when it convinces people to join, but not so good when it alienates through pretension or exclusivity.

Outlaws also occupy frontier spaces. But frontier can mean many things. In DIY Bio, it means occupying the frontiers of where and how science is conventionally conducted: in garages, in community labs, through dumpster-diving and ebay-scouring, with cobbled-together equipment and cheap kitchen equivalents. But in terms of Big bio, who doesn't want to be at the frontier? The very structure of science demands that every scientist madly search for the edge of the known. But there are outlaws even here, those who have gone past the frontier (literally, the front) and into the wilderness, out ahead of the advancing army, and obviously at great risk. These outlaws-within-the-establishment are those who insist on questioning the dogmas of established biology, even at the risk of being ignored (often) or expelled (occasionally). These are the outlaws who claim to understand the causes of cancer or who can cure malaria, if only everyone would just listen to them; these are the outlaws who would engineer a new life form, just because people say it can't be done. Such outlaws are not beyond science — their prize is still the Nobel — but they suffer exclusion by the stuffed shirts in the elite institutions who never believe their theories. Some are farther out in the wilderness that others, and some have lost contact altogether.

Synthetic Biology, which at this point in history is the principle source of much of the hype and excitement around DIY Bio, Open Source science, bio-hacking and so forth, is a wilderness space of this kind. Panelist Gaymon Bennett has spent several years immersed in the lives and worlds of outlaw biologists in synthetic biology, with collaborator Paul Rabinow.[9] Focusing on the "human practices" of synthetic biology, Bennett has seen the field develop from a set of un-named practices within bio-engineering, to the *bête-noire* of mainstream biology, to a field boasting a vibrant international community of eager participants, including the annual International Genetically Engineered Machines contest, which has probably done more than any other event to create a generation of biohackers. Despite a reputation for openness and an avowed filiation with MIT hackers, the figure of the outlaw dominates the stories and articles about synthetic biologists: an Outlaw mentality feeds egos and individualism and creates an obsession with the technical and powerful, rather than creating an openness to public participation, or a sensitivity to diverse social goals.

But to reiterate, Outlaws are not criminals — at least not yet. Rather, it is *legitimacy* that troubles the outlaw today. In this age of the massive decentralization of media, in the age of terrorism and preparedness, in the age of social networks and crowdsourcing, who decides which biology will triumph? Who decides whether it is the big biology companies and (once) well endowed universities that set the agenda for the future, or the visionaries, the creatives, the silicon valley ideologues, the people, the outlaws? All of the topics presented in this symposium struggle with legitimacy: should we take synthetic biology or DIY biology seriously? Who should study which diseases and what should count as

knowledge about them? Whose innovation counts as real and new? Being beyond the law doesn't mean being beyond good and bad, but it sure does make people anxious.

Which public, whose participation?

For all the recent attention on DIY Bio, forms of public participation in science have a much longer history. "Participation in science" can mean a lot of things, from buying products that are the results of science and engineering, to doing a Christmas Bird Count, to engaging in model rocketry, using chemistry sets or Ham radios to attending lectures at (a public) university, to doing science experiments or making art in your garage or studio. All of these things are happening today, and the question we pose here is: why? Why are more and more people participating in science both within the established and elite institutions of science and in all sorts of unlikely spaces? What is public participation doing to science and engineering as we know it? What is it doing to civic values, ideas of democratic accountability, or problems of regulation and safety?

When we say "science and engineering" today, we tend to mean universities and corporate organizations like biotechnology companies, pharmaceutical firms, and research labs. Implicitly these organizations filter who is inside and who is outside. Those who set the agenda, create the experiments, pursue knowledge are on the inside of these organizations and those who consume it, react to it, or suffer its implications are on the outside. A nice clean division. But in light of this division how should we understand patient advocacy groups who fund research on rare diseases? What do you do with projects that invite public and citizen science like SETI@home, Folding@home or Galaxy Zoo? Organizations like the Methuselah Foundation (which seeks to end aging) or the Templeton Foundation (which seeks to combine science and religion) also fall outside the nice clean science/public divides, as do any of the hundreds of slightly kooky charities funding science and engineering just outside the realm of legitimacy. Vast numbers of Free and Open Source Software projects help participants organize via the internet, spend their own time and money setting an agenda and then achieving it with the help of volunteers from around the world. Are such people "the public"? Are they rogue scientists and engineers? Are their goals and methods also scientific, are they safe, are they legitimate? Are they outlaws, hackers, Victorian gentlemen, or just scientists? Do we need a new language for new hybrid forms of science-making?

One place “public participation” has gotten no shortage of attention is in the case of “open source” and in particular the application of open source ideas from software to science and engineering. Several of our panelists have dabbled in this: Roger Brent is a biologist, once upon a time a computer scientist, now in the division of basic sciences at the Fred Hutchison Cancer Center, who has long tried to open up scientific research to forms of public engagement, to seed open source science, and to critique the directions scientists take with their research. Brent’s Molecular Sciences Institute, (founded with Sydney Brenner, and erstwhile home to budding synthetic biologists like Drew Endy and Rob Carslon) was one of the first free-standing academic genomic research labs to stake itself on the path of “open science” — resistance to patenting and copyright, openness to widespread participation, and a desire, or a hope, for the benefits of massively distributed parallel cognition. And Jason Bobe also wears this other hat — as director of the Personal Genome Project, which aims to make public the genetic sequence of ten, a hundred and eventually a thousand volunteers. Bobe and his boss George Church are prophets of an open genomics, including an open source genomic sequencing system and an open book of rich data generated from willing participants.[10]

But why is public participation different today? What is making it increase in scope and scale? The perhaps paradoxical answer is that Big Bio itself has enabled participation and openness, whether it has intended to or not.

Creativity breeds creativity

In his famous work in the history of genetics, Robert Kohler explained how the humble fruit fly, *Drosophila Melanogaster*, transformed our understanding of genetics.[11] The geneticist TH Morgan bred the flies in large quantities in order to find mutants; he used these mutants to determine the transmission of characteristics by breeding them, which in turn generated more mutants. Kohler called the fly a

biological "breeder reactor" for genetics, a chain reaction in which created more material for experiments in evolution than was used up in the process of understanding genetics.

This notion that the creativity of a fly led to the creativity of a scientist and his colleagues repeats itself throughout the history of biological research. Tissue culture researchers in the 1950s, as Hannah Landecker has explored,[12] created the means for generating more material for analysis — cells in dishes — than could possibly be used in experiments. It opened up experiments in cell fusion and made monoclonal antibodies possible; it set the stage for hotly politicized stem cells to exist in freezers and be circumscribed by federal laws. Something similar might be said about the information that results from sequencing genomes: the more information we gather, the more it produces — annotations, linkages, comparisons, patterns and errors for further analysis. Creativity breeds creativity.

This situation of abundance is also one that faces biology today. The Human Genome project has come to an end, and rather than close the much-discussed "book of life" once and for all, it has done exactly the opposite: generated libraries upon libraries of books — more books than anyone can read or understand. Not only that, but the need for tools to sequence genomes has resulted not just in a few good sequences, but in the proliferation of hundreds, probably thousands, of new tools and technologies for extraction, for synthesis, for analysis, for typing and mapping and sequencing. Centrifuges, thermocyclers, DNA synthesis machines, gene chips of seemingly uncountable variety, specificity, and branding, to say nothing of the proliferation of databases upon databases. The National Center for Biotechnology Information lists dozens of databases, many of which represent the compilation of dozens more, and so on — all of them paid for and freely available to the public.

Based on this recent abundance, the work of Philip Lukeman (another panelist at the Symposium), wouldn't exist. Although most of the research that led to this abundance was focused on understanding DNA as an informational molecule central to life processes, it is nonetheless a molecule. Phil, a chemist, knows this well: he is engaged in a hybrid of science and engineering using DNA as a molecular tinker-toy set. Chemists have long synthesized — tinkered — with nanoscale structures. In the last 10 years, the ability to tinker with DNA was initiated in part by Ned Seeman at NYU, who engineered a (in Phil's words) "quite severe and impressive hack" that has allowed the same tools of investigation to be used for engineering, like the cheap, easy synthesis of very complex DNA-based structures. Phil's experimentation isn't yet garage-cheap, but it is indubitably faster and more flexible than ever before. And as it gets cheaper and easier to do, it opens the door to widespread public engagement and participation in the synthesis and engineering of nano-scale structures — including to fields like design and art where definitions of what is valuable to do with DNA may differ substantially from those of engineers or biologists.

But is this public participation a form of citizen engagement, or is it simply a leaky boundary between what used to be elite science and something slightly less elite? Is it merely a matter of changing perceptions of expertise and elitism, or does it represent a more general transformation of science? What has changed?

In the early 20th century, TH Morgan had an elite club, cushioned from public scrutiny or involvement and even partially invisible to the mass media by being, to put it bluntly, kind of boring and a bit geeky about fruit flies. If they weren't in elite universities and institutes they might be Victorian Gentlemen entomologists — bug fanciers with an audience of rapt socialites interested in the mysteries of a humble organism. Were they not immediately recognized and respected as scientists by their peers, and if there had been a dogma to reject in genetics they might have been Outlaws.

Morgan and his "fly-boys," however, were *hackers*. They built an extensive global network of fly geneticists who shared the information and the mutants via a kind of proto-internet newsletter and scholarly community called the *Drosophila Information Service*. They stitched together a research agenda out of an easily found species, and a bunch of ad hoc, cobbled-together tools. Their newsletter is full of clever suggestions for hacking flies: fly-food recipes, techniques for counting flies, tools to keep them warm, or cold, suggestions about how to pursue one line of research or another. They were artisans and craftspeople of science, but ones willing to standardize and extend their practices, to incorporate other fly geneticists and eventually to dominate the field of genetics with their language and approaches until the advent of molecular biology of genetics of the mid 1950s and 1960s. They were the elite Hackers, the outsiders who became the establishment — a well-known trajectory in the history of American science and technology.

But today, things are much different. Our universities are saturated with commercial commitments, intellectual property agreements, federal legislation, ethical observers, rapidly changing information

technology infrastructures, animal rights and anti-science protesters and much more. Pharmaceutical companies and research firms are brokering research projects (and new buildings) all around our campuses; technology transfer offices are struggling to make good on the demands of the Bayh-Dole Act, patenting and licensing as best they can; research of all kinds is regulated to the hilt, whether that means the mundane and sometimes invisible regulation of lab safety, or the oversight of research on human subjects, or the bans on cloning and embryonic stem cells; and at UCLA, at least, protests against research are a regular occurrence, most notably that involving animals, which has made UCLA (among others) into a surprisingly dangerous place to do some kinds of biological research.

In Big Bio today, $100,000 machines are the coin of the realm. Massively parallel genetic sequencing, SNP-chip based Genome-Wide Association Studies, clinical trials in the tens of thousands and revenues in the trillions are the stuff of this science. This is Big Bio in the elite institutions and corporations of the 21st century. These are the rich that Outlaw Robin Hoods would steal from today. It is a land of promises and revenues; it is the reason why patent lawyers are a standard fixture in biology labs today and the tableau for the epic battles of Merck and the FDA. But it is also the source of cheap (and getting cheaper fast) DNA synthesis. It is the source of glassware and gel stains from huge scientific supply houses, cheap and abundant internet connections or free software for everything from statistical analysis (R) to bio-informatic analysis (bioperl) to hardware hacking. Big Bio has built an incomparably sophisticated infrastructure within which we, you, all of us, can pursue science.

Big Bio may not *invite* public participation, but it certainly *enables* it. Consider two other panelists: Hugh Rienhoff and Victoria Vesna. Hugh has been many things, but is at heart an MD, a clinical geneticist and a father. He spends his spare time at home sequencing his daughter Beatrice's DNA in order to identify candidate genes that might contribute to her mysterious, undiagnosable, muscle-wasting disease. Hugh uses all the databases, the tools, the laboratory expertise of the Human Genome Project and its abundant success. He collaborates with scientists, he aligns his interests with theirs — which is sometimes a desire to contribute to research, sometimes a chance to do research on "something that matters." Hugh is the Victorian gentleman scientist par excellence — indeed he was the one who suggested this figure for the symposium. With intelligence, good manners, and the help of many eager friends, he may help his daughter, and he will almost certainly contribute to the knowledge of both her specific condition and others like it. But this figure is an uncertain one today.

Victorian amateurs of the 19th century (properly speaking, the pre-victorians) like Joseph Banks the botanist or Sir Humphry Davy the chemist were more like renaissance men with independent means and a curiosity tied to their political and social ambitions. They may not have had careers as scientists *per se* (it's arguable whether such careers even existed, cf. Shapin 2008), but both Banks and Davy served as presidents of the Royal Society. Today a figure like Rienhoff is unlikely to become president of a scholarly society, and his quest is a modest one, but he does share some characteristics, especially a powerful network of friends and colleagues who he can draw on for help, combined with an independence from career considerations that allows him to be more speculative, take larger chances, or explore less prestigious solutions.

Victoria Vesna represents a similar appropriation of Big Bio: the impressive growth in bio-art over the last decade — artists eager to and willing to collaborate with scientists, learn biology, and experiment with the tools made available by Big Bio: green fluorescent proteins, petri dishes, tissue culture manuals, and genetics databases; but configures them in ways that try to provoke, transgress or re-design our understandings of life. More than Victorian science or DIY Bio, bio-art depends on Big Bio not just as a source of surplus but also as a target of critique. A vibrant community of critics and artists had grown up around this practice, for reasons that are very rarely aligned with the immediate goals of the science and engineering infrastructures that enable it.

Even a field like “recreational genetics” (or "direct to consumer" genetic testing) has sprung up in the rich nutrient bath of cheap testing and sequencing tools and the abundant public data for making claims about diseases, about ancestry and about risk. Gene Chips are rapidly becoming commodities — off the shelf automatic tests rather than bespoke and finicky laboratory procedures. And public datasets are being supplemented by hundreds of private data source — some scary like the private DNA databases of The Orange County District Attorney,[13] some more benign, like DeCode's massive pool of the DNA of Icelanders that promised so much, and as of October of this year, delivered very little to its investors.[14]

Creativity breeds creativity. If anything can be said about the expansion of forms of public participation in biology — whether by outlaws, hackers or Victorian gentlemen — it is perhaps that the more

innovation there is, the more innovation there is. Even if what counts as innovation is different for outlaws and hackers than it is for scientists and engineers who've made it, it is clear that it not some linear form of accumulation. What remains an open question, perhaps, is whether we are in control of any of this innovation, or if it controls us?

And what of the public?

Hackers, Outlaws and Victorian Gentleman all represent new ways of science-making, new forms of engaging with the abundance of tools, ideas, systems and infrastructures to innovate and create. Undoubtedly, science is changing. But we might also ask what's happening to "the public"? DIY Bio, patient advocacy, Open Source Software, even participating in clinical trials for the good of humanity, change what it means to be part of the public.[15] Being in the public is not passive in any of these activities — but aggressively active, and about knowledge, access, experiment and involvement. These are not the publics of public opinion polls and scientific literacy. Are the examples arrayed here as much "outlaw publics" as they are examples of an outlaw science? So little attention is paid to what really counts when it comes to being a member of the public that maybe it is time to ask whether the real dangers facing us are not unregulated uses of biology, but unregulated uses of public power? Who do Outlaw Biologists speak for, and how? What innovations do they pursue and for whom?

What kinds of publics are they making, exactly, out there in their garages and home labs?

Notes and references

[1] http://outlawbiology.net/.

[2] A. Liu (2004), *The Laws of Cool: Knowledge Work and the Culture of Information*, Chicago: University of Chicago Press.

[3] S. Shapin (2008), *The Scientific Life. A moral history of a late modern vocation*, Chicago: University of Chicago Press.

[4] P. Rabinow (1996), *Making PCR: A Story of Biotechnology*, Chicago: University of Chicago Press.

[5] P. Rabinow (1999), *French DNA: Trouble in Purgatory*, Chicago, IL: University of Chicago Press.

[6] M. Wohlsen (2008), *Hobbyists try genetic engineering at home*, MSNBC/ Associated Press, December 26, 2008, http://www.msnbc.msn.com/id/28390773/.

[7] G. Bennett et al. (2009), *From synthetic biology to biohacking: are we prepared?, Nat Biotech* **27**:1109-1111.

[8] M. Schmidt (2008), *Diffusion of synthetic biology: a challenge to biosafety*, *Systems and Synthetic Biology* **2**:1-6.

[9] P. Rabinow and G. Bennett (2009), *Synthetic biology: ethical ramifications 2009*, Systems and Synthetic Biology **3**:99-108.

[10] G.M. Church (2005), *The Personal Genome Project*, *Molecular Systems Biology* **1**:30.

[11] R.E. Kohler (1994), *Lords of the Fly: Drosophila Genetics and the Experimental Life*, Chicago: University of Chicago Press.

[12] H. Landecker (2007), *Culturing Life: How Cells Became Technologies*. Harvard University Press.

[13] http://articles.latimes.com/2009/oct/05/local/me-oc-dna-database5.

[14] http://www.nytimes.com/2009/11/18/business/18gene.html.

[15] S. Roosth, *Crafting The Biological: Open-Sourcing Life Science, From Synthetic Biology to Garage Biotech*, Manuscript, on file with author.

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