The London School of Economics and Political Science

How did DNA become hackable and biology personal?

Tracing the self-fashioning of the DIYbio network

Sara Tocchetti

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Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I declare that my thesis consists of 91,860 words.

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Sara Tocchetti, September 2014

Per Andreina e Sally

Abstract

The DIYbio (Do-It-Yourself biology) group was established with the aim of turning biology and biotechnology into a creative practice accessible to everyone. The group is composed of graduate and post-graduate students and drop-out graduate students, but also disenfranchised researchers and professionals who see in the initiative the possibility of reviving their passion for science. Inspired by the analogy of the personal computer as a 'spokes-technology' for a free, egalitarian and decentralized society, that of the free and open-source software movement, and inspired by the image of the Victorian amateur and his home laboratory, DIYbio members organize regionally in what they call 'community laboratories,' or they practice in the comfort of their homes.

Based on a series of interviews with DIYbio members, participants' observations of DIYbio's transient practices and a literary analysis of DIYbio members' use of social media, this thesis traces what I provisionally call 'the making of a personal biology.' Starting from the narrative formation the network, it then moves from the foundation of the DIYbio network in 2008 to the establishment of the first 'community laboratories', tracing the contingent orchestration of a diverse set of people, sites, tools and events, into a four-year community building effort.

Due to its recent emergence in the field of Science and Technology Studies, only a limited number of research initiatives engage with the DIYbio network. Such works, mainly in the form of dissertations chapters and short articles, are analytically rich but limited in their observations, and often focus only on specific aspects of the network (Aguiton, 2010; Roosth, 2010; Delfanti, 2011; Meyer, 2012). This thesis recognizes the emergence of the DIYbio network as a cultural phenomenon in itself, and addresses the gap in the literature by tracing how DNA became hackable and biology became personal. Following Donna Haraway's effort to critically address the politics of technoscience as a practice of 'turning tropes into worlds' (1997: 59), the overarching topic of this research is how the trope of the biohacker became a world, and what type of world it became. The aim of this research is, therefore, to explore how members of the DIYbio network and biohackers define themselves, construct their identities and organize their work. This research also aims to situate the discourses and practices of DIYbio members in a context where governments and industries are intensifying their effort to make the coming century of biology into a reality.

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Acronyms and shortened words used in this thesis

AL	Artificial Life
AMBL	Advanced Molecular Biology Lab from the University of British Columbia
DIYbio	Do-It-Yourself Biology
DNA	Deoxyribonucleic acid
ESRC	Economic and Social Research Council
FBI	Federal Bureau of Investigation
GMO	Genetically Modified Organism
iGEM	International Genetically Engineered Machines
indieBB	Independent BackBone
MIT	Massachusetts Institution of Technology
MTA	Material Transfer Agreement
PCSBI	Presidential Commission for the Study of Bioethical Issues
PCR	Polymerase Chain Reaction
STIP	Science and Technology Innovation Program
STS	Science and Technology Studies
TED	Technology Entertainment Design
UCLA	University of California Los Angeles
WWC	Woodrow Wilson Centre for International Scholars

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Note 1: The photos throughout this work are attributed to the author, Sara Tocchetti, unless otherwise attributed in captions or footnotes. Photos are also aligned as best as possible given their size and other textual constraints in the formatting of this thesis.

Note 2: There are several website references throughout this work. For consistency and clarity in text, websites are referenced as footnotes in the body of this work.

Introduction

Hacking_DNA@home.org?

On the 16 July 1977, the whole front page of *The Real Paper*, the principal Boston-based alternative newspaper, was occupied by a cartoon illustration of a can of Botulism soup.[1] The image was tagged with a label advertising an alarming sales pitch: DOING DNA AT HOME: A RECIPE FOR BOTULISM. While the illustration explicitly recalled Andy Warhol's cans of Campbell's tomato soup, Warhol's artistic intention was made into a *détournement.*

Figure 1 From art to biotechnology.

The Real Paper's 1977 version of Andy Warhol's, 1962 Tomato Can.

The Real Paper's graphic designers replaced Campbell's logo with a skull, added the branding qualification of 'homemade' to the industrial soup, no longer referring at it as 'condensed' but instead as 'recombinant DNA' (Morgan and Youderian, 1977). Warhol's commentary on the aesthetic of mass consumption was turned towards biotechnology. The accompanying article, entitled 'Doing recombinant DNA experiments at home recipe for Botulism' opens with the assertion that with less than $350 'you' could do dangerous recombinant DNA experiments at home and that no one could tell 'you' not to do it. By drawing attention to this possibility, the authors

1 *The Real Paper* was a Boston alternative weekly newspaper in circulation between 1972 and 1981. It reached a maximum of 100'000 distributed copies and was part of what back then was called the voice of the counterculture. For an introduction to the alternative press studies see McMillian (2011). Botulism is a possibly lethal intoxication caused by botulin, a protein synthesized under anaerobic conditions by the bacteria *Clostridium Botulinum*.

invoked public concern about the 'weak and noneexistent' (1977, para. 3) attempts to regulate research using recombinant DNA techniques and gave evidence of how the National Institute of Health's (NIH) guidelines, published in 1975, were, two years, later still unknown to, or disregarded by, a majority of academic researchers.[2] Given the threat posed by such lax regulation, the newspaper justified the choice of publishing a recipe for the production of home-made botulin as a 'calculated shock,' a preventive media action motivated by the belief that their proposition of an alarming experiment 'may help prevent larger ones.' (ibid.: para. 22) They further argued that, as for other technologies, the real danger was less what they named 'terrorists in the basements labs' and more the mainstream scientists who might be 'meaning well, working under the best conditions, [but] occasionally erring or cutting corners once too often for the public good' (ibid.: para. 23). The steps of the recipe for botulism were purposely phrased using benign domestic cooking terminologies and expressions such as adding a 'pinch of E. coli' and a 'dash' of restriction enzyme or to 'skim botulin bacterium paste,' 'ladle into chilled soup cups, and season to taste' (ibid.: para. 32).[3] As the journalists explained, the recipe was 'incomplete but dangerous nonetheless,' and they concluded by stressing that the choice to publish it was 'clearly not in the hope that anyone would take it to heart and follow it' (ibid.: para. 35).

A decade later, in January 1988, another recipe based on recombinant DNA appeared in the US press. It was published in a much more influential newspaper, *The Washington Post*, as part of an article titled 'Playing God in the basement' (Schrage, 1988, D3). This second recipe was proposed as an entertaining intellectual exercise by the president of research and development at Calgene, a leading biotech company. It was entitled 'Mutants du Jour: An imaginary Recipe,' and described how to insert the luciferase gene into a tomato sprout by transfection.[4] In this case, the tomatoes where not another provoking culinary experiment; instead the idea was to delight readers, for whom the final step of the recipe would be to 'sit out on the porch and watch your crop

2 The NIH's guidelines were published in the aftermath of the Asilomar conference held in 1975. The Asilomar conference on Recombinant DNA was organised to discuss potential biohazards related to the emerging technology. For an historical and critical introduction to early public concerns about genetic engineering see Susan Wright (1994) and Erich Vettel (2006).

3 *Clostridium Botulinum* does not need to be genetically modified in order to produce botulin.

4 DNA transfection is a technique allowing the insertion of DNA from other species into plants by infecting their regenerative tissues with *Agrobacterium tumefaciens.* It was a major development in plant molecular genetics, and was first described in 1977 (Schell and Von Montagu, 1977). The luciferase gene codes for the expression of the enzyme responsible for bioluminescence. The first paper describing the stable expression of firefly luciferase gene in plants was first published in Science in 1986 (Deluca, 1986).

glow' (1988, D3). The journalist and the interviewees, all distinguished professors and chief scientists of major biotech companies, let themselves imagine a future where 'beaming children' would present their glowing sheep and tomatoes at 4-H meetings.[5] A future in which 'gardeners might be able to produce interesting and robust plant strains; genetic entrepreneurs could breed pets with certain characteristics, and eventually, individuals might be able to scan their own gene map at home to see what predisposition they possess' (ibid.: D3) Backed by sociologist Everett Roger's theory of technological diffusion[6], the author announced that 'the path of biotechnology parallels the diffusion of personal computing technologies.' (ibid.: D3). Under-girding the emergence of what the journalist named a 'technology subculture,' was the 'computer revolution' (ibid.: D3), an inevitable pathway whose central figure was 'the bio-hacker' (ibid.: D3). Such a bright future was nonetheless briefly reconsidered in a slightly dramatic conclusive remark, where the author claimed that:

> The truly frightening aspect of this technology isn't that the occasional outlaw will emerge. It's that society's beliefs about the nature of life will be so fragmented and confused that there will be no ethic for bio-hackers to emulate. In which case, all bets are off (Schrage, 1988).

I introduce these examples as discursive glimpses of a material-semiotic field in its formation, and because I think that there is something at stake in the space between them. If, in order to keep the politics of recombinant DNA in the public sphere, the first article suggested the shocking idea that everyone could produce botulin in their basements,[7] the second paper proposed home-made DNA as an entertaining intellectual exercise, or a playful invitation for readers to join the ongoing scientific celebration of DNA reprogramming. Yet both articles attempted, in different contexts and for radically different reasons, to portray the unfamiliar possibility of widely available recombinant DNA technologies as, in fact, deeply familiar. This familiarity

5 4-H stands for *Head*, *Heart*, *Hands*, and *Health.* It is one of the largest youth organizations and is administered by the National Institute for Food and Agriculture. Available at: <http://archive.org/details/gov.usda.nal.dvd.339.2> Last accessed 2 November 2012.

6 The Diffusion of Innovation theory (DoI) is a sociological theory aimed at explaining how a new technology is adopted by a social group. The curve of diffusion, described by a Gaussian distribution, is divided in five major groups: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards (Everett, 2003 [1962]). While the theory is still used by development agencies, policy maker and research audit organizations, it has been criticized for its reductionist approach. More recent theories connect innovation adoption to innovation path and includes, among others, contingency (Mokyr, 1992), path dependence (David, 1985), or (Hughes, 1993).

7 The term 'leftists journalist' is used here in reference to the countercultural journalistic tradition of which the Real Paper was part of. For an introduction see Donna Lloyd Ellis on the underground press in America (2004).

was presented as a techno-scientific and epistemological imperative for the conscientious modern citizen.

Discontinuously but incrementally, over the past two decades the tropes[8] of home-made DNA, of biotechnology as the next personal computer revolution, and of the figure of the bio-hacker, have gained momentum. Scientists working on DNA sequencing and open source software tools for bioinformatics (Regis, 1994; Counsell, 2004), and journalists occupied with the forecasting biotechnology's future (Katz, 1990; Schrage, 1992; Eudes 2002), including renown science fiction writers (McAuley, 2000), have started reconfiguring, disseminating, and becoming concerned about these discourses and figures. Around 2005, this distinct rhetorical repertoire became used by the founders of synthetic biology[9] and their closest Ph.D. and graduate students. In particular, figures such as Tom Knight, a computer engineer turned bioengineer, but mostly Drew Endy, a civil engineered turned bioengineer, and Robert Carlson, a physicist turned garage biologist and consultant, established themselves as strong advocates of an 'open source biology' (Carlson and Brent 2000; Carlson 2001 and 2004). For them, the assimilation of the hacker culture of the MIT, but also of its more recent legacies such as the free and open source software movements, were a way of imagining biology as yet another substance to be creatively manipulated, constructed and freely shared (Roosth, 2010; Campos 2013). This 'hackerly source of synthetic biology,' as Sophia Roosth calls it (2010: 83), was also a legacy infused in the major educational project established by founders of the field; the international Genetically Modified Machine (iGEM) competition. There, each year since 2009, hundreds of teams of international undergraduate students compete by dreaming up genetically modified organisms as solutions to the world's problems (Cockerton, 2011). Sharing genetic constructs as part of a common repository is an obligatory rule of the competition. The organisers also incite student creativity and entrepreneurial spirit by promoting the genome as the site of limitless production:

8 The term trope is used in reference to Hayden White's work on the tropic nature of understanding (1985). According to White 'tropic' refers to 'the process by which all discourse constitutes the object which it pretends to describe realistically and analyze objectively' (1985: 2). As such understanding can only be tropological by nature, for what is involved in the rendering of the unfamiliar into the familiar' (1985: 5). A work that Haraway adapted to the analysis of the politics of technoscience as a practice of 'turning tropes into worlds' (1997: 59).

9 Synthetic biology is a recently emerged discipline aimed at applying engineering principles in biology in order to enable a more standardized manipulation of living organisms (Endy, 2005). For an ethnographic account of synthetic biology and Endy's role, see Roosth (2010, Chapter 2).

from desertification to dental cavities, at iGEM each problem has its genetic solution (Aguiton, 2010). But it was in 2008, at the productive margins of these initiatives, that the most recent and ambitious attempt to make the bio-hacker and the personal computer's trope into a new biotechnological world was established. This came under a name: DIYbio, for do-it-yourself biology.

Drawing on the analogy with the personal computer and other personalized technologies, DIYbio members envision the biological as a creative and innovative personal technology to be made available to everyone. The network is composed of self-proclaimed biohackers, amateur biologists, citizen scientists, and garage biologists. A majority are current or drop-out graduate and post-graduate students – most of which have participated to iGEM – but some are also disenfranchised researchers or professionals who sees in this initiative a possibility to revive their passion for science. A minority are science communicators, designers and artists interested in the informal access to tools and materials, interdisciplinary practices or discourses of science democratization (Wray, 2012). Most members are active in the USA and Europe but more recently also in Asia. The network organizes both online and offline, nationally and internationally, often via members affiliating themselves with events organized by more influential organizations. These include gatherings of researchers in the field of synthetic biology or new forums of creative manufacturing such as start-up incubators and accelerator events.

Regionally, DIYbio members form community laboratories, while a minority work in their homes, or between university, corporate and community or home laboratories. Community laboratories are run collectively, and frequent activities include a variety of biology and biotechnology[10] classes, hands-on workshops, and informal gatherings aimed at coordinating the network nationally or internationally. Hands on activities include the fabrication of cheap and user-friendly laboratory instruments suitable for exploratory genomics, microbiology and genetic engineering, or the observations of micro-organisms. The most common demonstrations include the extraction of DNA from fruits or buccal scrub samples using household ingredients; the genetic modification of bacteria or yeast; the identification of species or phenotypes distributions by amplification of genetic polymorphisms; testing oneself or

10 Throughout the thesis, when is not specified, I use the terms biology and biotechnology together in order to highlight that as part of DIYbio network practices such as breeding snails, making yoghurt and genetically modifying bacteria are considered part of a continuum.

someone else for a gene; the use of gene sequencing and synthesizing services; the growth of bacterial and fungi biomaterials; and the preparation of fermented products.

The running costs of the laboratories are covered by subscription fees, class fees, science educational grants, fund-raising campaigns on the Internet, and, more recently, funds from angel investors. The most advanced community laboratories host iGEM teams in collaboration with universities, or function as incubators for small biotech start-ups. Most of these activities are also performed in collaboration with science festivals, sci|art events, educational charities, modern craft fairs and computer-hacker events. In just a few years, and mostly due to their proximity with the field of synthetic biology, and their entrepreneurial ideology, DIYbio members have attracted the attention of influential technology magazines and the mainstream media. Journalists have portrayed them both as a biosafety and a biosecurity threat, as well as the source of the next technological revolution. More recently, thanks to their proactive relation to regulators, DIYbio members have also gained the support of American and European governmental agencies and national science education programs, who see in their practices an additional venue for strategic science education.

In conjunction with the two newspapers articles, the dissemination of the trope of biotechnology as the next personal computer revolution, and the figure of the bio-hacker, the introductory portrait of the DIYbio network reads like a prediction coming true. One that not only supports Everett Roger's theory of diffusion of innovation, but even extends its influence by demonstrating that the diffusion of one technology (i.e personal computers) can be used to predict the development of another one (i.e personal biotechnology). And yet, far from such deterministic readings of how technologies might be adopted, my interest lies, instead, in the way in which technoscience, as a mode of address, and also as a practice of 'turning tropes into worlds' (Haraway, 1997: 59), reconfigures human and non human actors, transnational economies, political expectations, as well as ideas of democracy and freedom. It is as an instigator of these concerns, in particular, that the DIYbio network, as a case study, offers us the possibility of thinking more carefully about the politics of turning tropes into worlds: worlds where DNA becomes hackable and biology, in its turn, entirely personal.

Having briefly situated the DIYbio network as a case study, in the rest of this

introductory chapter, I want to work carefully through some of the ways in which scholars have made sense of the numerous borrowings that have taken place between computer and information sciences models, metaphors and machines and the life sciences and what exactly these borrowings have made possible. I continue by mapping how recent borrowings are understood, in particular the ones from the free and open source software movements. Following Fred Turner's historical analysis of *digital utopianism,* I argue that the computer as an object that is both personal and networked ceases to be 'only' a metaphor, a model or a machine; it becomes, in addition, a 'spokes-technology' for a decentralized, egalitarian, harmonious and free society. From this perspective, I argue, that the literature interested in the borrowings between computer and information sciences and life science do not to situate what the rhetorical politics of freedom, decentralization and empowered individualism, which accompany the personal and networked computer, actually *does* when it is used to make sense of life. I will go on to suggest that one of the most recent and significant borrowings is that between a reconfigured version of digital utopianism and the life sciences. In this sense, the DIYbio network is a unique case study to investigate what I provisionally call the making of a *personal biology*. I then summarize the emerging academic literature on the DIYbio network and describe how my research questions and my approach are complementary yet distinguished from the one presented in the literature. The choice of presenting the literature at this late stage reflects the fact that this literature only emerged during my research period (spanning between 2009 and 2013). Therefore, I could not start from it, but simply work through and with it. Finally, I conclude by presenting my methodology and outlining the different chapters of this thesis.

Making sense of life: computers as metaphors, models, machines and tropes

Amidst the multiple trajectories undertaken by the cultural analysis of technoscience, the study of the artificiality of the distinctions between nature and culture has recently occupied a central place. A process of revision during which, as Sarah Franklin poses it, 'the biological increasingly refers to *mixtures* of the biological and the technical as is ubiquitously signified by vaguely potent prefix 'bio-' as in the biosciences, biomedicine, biopolitics, or bioethics' (Franklin, 2003: 69). Bio- as a prefix in biohacking and as a suffix in DIYbio can be, in conjunction with the metaphor of the

personal computer, at least partially understood as a specific reconfiguration in this long-standing tradition. In what follows, I summarize and organize scholarly works according to the effects of the *cultural borrowings*[11] that they have described as ongoing between the life sciences and the computer and information sciences.

For Susan Oyama (2000 [1985]), computer sciences metaphors, such as 'genetic blueprint,' 'symbols,' 'instructions' and 'programs' are mobilized by researchers in the field of genetics in the process of figuring out the function of the gene. She critiques the effect of such borrowings, namely that these terminological choices actualize the tradition of reformationism (the gene as homunculus) expressed through the dogma of genetic determinism or ontogeny (Oyama, 2000 [1985]). Similarly Richard Doyle (1997), whose work traces the tacit rhetorical shifts in the representation of the chromosome as the 'coder,' the 'decoder,' and as a container of concentrated order, critiques the use of such metaphors since, he argues, they support the displacement of biological agency towards the chromosome. The possibility that computer sciences metaphors are a discursive relay of determinism is further investigated by Lily Kay (1993), whose work questions the increasing agency of computational metaphors, from scientific epistemic practices to researchers' institutional culture. In particular she argues that the use of terms such as 'information coding' and 'genetic code' reinforced the institutional tradition of the science of social control as putted into action by the Rockefeller Foundation (Kay, 1993).

Evelyn Fox Keller (1995) marks a first departure from these types of analysis where the computer as a metaphor is understood as reinforcing different forms of determinism, and researchers in the life sciences are in part represented as passive receivers. Using the same example as Doyle, i.e. Schrödinger's notion of 'code script,' Fox Keller instead illustrates how such a definition was problematic for the study of development as it was considered too reductionist and eventually rejected by developmental biologists (Keller, 1995). Similarly she also notes how the use of the term 'genetic program' was actually surprisingly undefined, inadequately

11 I myself borrowed the term *cultural borrowing* from Sarah Franklin who uses it to describe how 'ideas (and tools) travel, connect, disconnect, and contain one another' (Franklin, 2003: 66). More specifically when dealing with the entangled tradition of biologics and informatics a multitude of expressions have been coined: Keller speaks about 'incursions' (2002), Roosth of how biology can to be 'articulated' in a computational argot (Roosth, 2010) and Bardini of how the cybernetic metaphors is 'applied' to life itself (Bardini, 2011). Despite the fact that the term borrowing might entail a certain directionality, the works of the authors reviewed in this section suggest that, in simple terms, there is as much computers in biology as there is of biology in computers.

oversimplified, and yet it productively framed the type of research questions to be undertaken (Keller, 2000). Interestingly, when in a later work Keller describes the effect of the metaphor of 'gene action' and 'genetic program' as it had become adopted in the gene-based narrative of development, she proposes that 'the program' is not any more the fixed encoded intentionality of the programmer, but has become the cybernetic view of computers where the design includes the capability of the machine to adapt, steer and organize itself (Keller, 2002). By doing so Keller questions not only the type of trafficking, but also how entangled the notions of computer and organism are. Despite that, some of these early works have been criticized for over representing the agency of language (see Susan Lindee [1997] for Fox Keller [1995], and Ann M. Penrose [1999] for Doyle [1997]).

A second departure, characterized by a move from a more contingent understanding of how discourses operate, towards others types of borrowings such as models and machines was already under way. Again it is Fox Keller who describes how, guided by the assumption that all material reality can be imagined as information, communication scientists found an important source of inspiration for the cybernetic model of feedback in the complexity of organisms. Ironically, the same model was adopted by molecular biologists who found in it a possibility thinking of organisms as a machines (Keller, 1995). The computer as a machine and as a space of simulation to make sense of life is also studied by Stephan Helmreich (1998). His work on Artificial Life (AL) investigates how researchers came to consider self-replicating computer programs not as mere representations of life but as actual life-forms capable of colonizing cyberspace. For the researchers in AL with whom Helmreich engages, the software as code can now initiate life *in silico* (Helmreich, 1998). Similarly Fox Keller, who also studies the field of Artificial Life, argues not only that the field offers the possibility to blur the boundaries between simulation and construction, but also that it continues the tradition of making computers more and more like organisms (Keller, 2002).

Despite this second departure, the computer as a model or a machine is still studied in the confined space of research institutions. It is in the *informatics of domination* that Donna Haraway actually maps the intertwined changes in class, race, and gender categories as occurring in a world order organized around what she names a 'polymorphous, information system' (1991: 161). In particular, by pointing out how

scholars have ignored the political economy of electronics and microelectronics, her work stresses the necessity of situating the implosion of biologics and informatics not only within the epistemic practices of technoscience understood as a confined discipline, but also of looking at the crossing of these practices and broader cultural productions (1991). Haraway's commitment is expressed in her description of the computer as a trope. 'Of course' she writes,

> 'computers' is metonymic for the articulation of humans and nonhumans through which potent 'things' like freedom, justice, well-being, skill, wealth and knowledge are variously reconstituted. 'The computer' is a trope, a part-for-whole figure, for a world of actors and actants, and not a Thing Acting Alone. 'Computers' cause nothing, but the human and the non-human hybrids troped by the figure of the information machine remake worlds (1997: 126).

Departing from the strict consideration of the computer's role in the cultural production of biologics and informatics boundaries, Haraway points at it as a site where fundamental issues such as 'freedom, justice, well-being, skill, wealth and knowledge' (1997: 126) are reconstituted.

In the last section of her work on *making sense of life*, Fox Keller writes, 'yet I cannot imagine this being the last word in making sense of life' (2002: 123). Her guess could have not been more appropriate, as, in the meantime, computers and digital technologies have remained a source of cultural borrowings for making sense of life. In particular two major aspects are investigated in the current literature. First, how information technology metaphors, especially related to the free and open source software movement, are shaping contemporary life science's epistemological practices regarding property regimes. And second, how this same movement is impacting the organization of scientific communities in the lifesciences.

Making sense of life: open source software as a legal and organizational metaphor

Following three patent application cases, where rights were claimed on the basis that genomes are 'computer-related inventions,' Adam Bostanci and Jane Calvert conclude that the idea of the genome as information is already participating in redefining legal classifications (2008:111). Calvert (2008) further investigates the relation between the epistemic status of biological entities and their commodification, proposing that reductionist approaches in the life sciences, including the use of computational

metaphors, are more prone to facilitate patenting. Lastly, in a special issue dedicated to how scientists in the emerging field of synthetic biology 'mobilize the potentiality of legal form' to shape ownership regimes (Pottage and Marris, 2012: 6), Calvert (2012) stresses that informational metaphors can serve distinct and often opposite purposes. This is an ambiguity that, she argues, demands of science and technology studies (STS) scholars that they abandon the critique of informational metaphors as a whole, and instead become 'alive to their indeterminacy and examine the work that they are doing in different contexts' (2012: 182). Similarly to Calvert, although explicitly engaging with broader political and social concerns raised by the governance of technosciences, Stephen Hilgartner addresses the question of the political ambiguity of open source metaphors in biology (2012). Taking again synthetic biology as a case study, he concludes by stressing that there is no guarantee that the discourses of openness characterizing the field are based on similar assumptions as the politics-of-technology discourses theorized in science studies (Hilgartner, 2012). Hilgartner's argument is of particular interest when reading the work of previous scholars, who, deeply concerned by the political economy of the life sciences under the intensification of financial investments and patenting, have been calling for a reflexive use of the open source software analogies in the life sciences (Hope, 2008, Deibel 2009).

If a majority of these works still look at discourse-centred practices, other scholars have extended these analyses to the study of how open source software ideals and tools are modifying the organization of life sciences communities, as well as their their moral economies. Concerned with the use of open source internet platforms such as Wikipedia, Adrian Mackenzie (2009) questions how the Wikipedia-like platforms, used by synthetic biologists to share laboratory protocols, community information, and materials, participate in the formation of what, throughout his work, he calls 'in-situ publics.' While he describes the political limits of these publics, he also argues that open source software tools promote participation, and that they might therefore support the gatherings of larger public around emerging techno-scientific issues (Mackenzie, 2009). Christopher Kelty situates these contemporary cultural circulations as reviving historical questions concerning the moral economy of science (Kelty, 2012). As with Calvert and Hilgartner, he argues that these metaphors are not to be considered as negotiating a difference between a 'closed' and an 'open science,' but

instead negotiate both notions under the scaled-up moral economy of contemporary biotechnology (Kelty, 2012). Finally, Roosth illustrates how in the early days of synthetic biology, computer hackers and open source software culture have contributed to the formation of researchers' identities and socialities (2010).

Under the theme of making sense of life, these two sections reviewed a number of ways in which the implosion of biologics and informatics have been studied. Yet while each of these analyses disentangle a portion of that relationship, their reading suggests that the computer, and more recently free and open source software, have mostly been considered as a source of discursive instruments, or as a technology used by researchers within scientific institutions. Similarly, while scholars have moved away from the reduction of the computer to a vehicle for determinism, and towards the characterization of hybrid and recursive relations, even the most recent literature concerned with the open source software movement fails to situate the politics of freedom, decentralization and empowerment accompanying these technologies, and the work that such a politics might do when borrowed to make sense of life. To do this, I turn to Fred Turner's historical analysis of how personal and networked personal computers became a 'spokes-technology' for a decentralized, egalitarian, and free society. Drawing on Turner's work, I suggest that some of the thickest recent traffic is occurring between *digital utopianism* and the life sciences. I conclude by arguing that the DIYbio network is an important case study to understand how this utopianism is reconfiguring a specific relation to the biological.

Digital utopianism and the computer as personal and networked

While in his book *From Counter culture to Cyberculture,* Turner does not give a dictionary-like definition of digital utopianism, the essay in itself can be understood as one. Turner begins by wondering how since the mid-1990s, personal computers and the internet came to be the 'spokes-technology' of a revolution that would bring to life an ideal society: 'decentralized, egalitarian, harmonious and free.' (Turner, 2006a:1). To answer this question, he traces the rise of what he calls *digital utopianism*, a pragmatic ideology composed of two intertwined legacies. On one side, the Second World War military-industrial research complex and in particular its 'free-wheeling, interdisciplinary and highly entrepreneurial style of work' (ibid.: 4). On the other side,

the Californian bohemian art world and the New Communalists of the late nineteen-sixties, whose members, disillusioned with confrontational and collective political actions, embraced small-scale technologies, including LSD, communes, and personal computers, as tools to transform individual consciousness towards social change. It is out of this imploded legacy, Turner argues, that personal computers and computer networks became media 'bring[ing] to life the countercultural dream of empowered individualism, collaborative community, and spiritual communion' (ibid.: 6). Following Turner's perspective means taking seriously the fact that the computer is not only a metaphor, a model or a machine. It is also a *utopia,* with its own political theory.

It is not surprising that in Turner's work, as well as my own, several actors and institutions are actually the same. Despite this digital utopianism and the trope of the personal computer cannot be considered as a fixed and all-inclusive analytical category. Rather, as Jenny Reardon has pointed out in a talk entitled *A genome is not an iPhone, or is it?* It is necessary to constantly question how freedom and democracy are imagined in digital technologies and the life sciences, especially when both digital technologies and genomics seek to become *relational* technologies (Reardon, 2011). Adapting her analysis of how the open access ethos operates in genomics and personal genomics to my own case study, I argue that the point is not to think the DIYbio network as an extension of digital utopianism into biotechnology, but instead to think it as a condition for biotechnology being situated as *for the people*. A biotechnology that is thought as more *just,* a development based on the idea that the new universal is unlimited participation (Reardon, 2013). In reference to the utopian legacy of the personal computer, I therefore use the term *personal biology* to grasp the socio-technical visions and practices that the members of the DIYbio network are experimenting with, and as a condition that needs to be critically untangled. In the next section, I show how the DIYbio network has emerged as a subject in the academic literature, and I introduce my research questions. I conclude by explaining how my approach is complementary, yet distinguished from the ones undertaken by other scholars.

The DIYbio network becomes a research subject

The DIYbio network was founded in 2008, and I started my research project in September 2009. As previously mentioned, the choice of presenting the literature at this late stage simply reflects the fact that this literature only emerged during my research period, and that I could not start from it, but simply work with it.

In relation to the promises of a biology that was easier and cheaper to engineer, disseminated by the founders of the field of synthetic biology, the formation of the DIYbio network has been first analysed as a biosafety and a biosecurity concern (Schmidt, 2008 and Bennett *et al.,* 2009). Biohackers are yet another uncertainty attached to this emerging field. Departing from such policy-oriented perspective, Sara Aguiton proposes that members of the DIYbio network participate in the replacement of *community norms* with what she names 'critical individualism' (2009: 36). This is a type of reflexivity according to which the submission or adaptation to moral or ethical criteria is no longer necessary, and 'difference and divergences are accepted and regarded as a possibility of new and innovative ideas' (2009: 40). Moral norms are also the point of entrance of Alessandro Delfanti's work (2010; 2011; 2012). He argues that a 'remix' of the Mertonian's norms and the hacker's ethic are brought into the life sciences, and that biohackers are an example of it. Citing Luc Boltanski and Laurent Thévenot's work on the 'imperative to justify' one's search for a new ethical norm, Delfanti understands such 'remix' as a symptom of a crisis in the proprietary regimes of biotechnology (Boltanski and Thévenot, 2006 cited in Delfanti, 2010:19). As Aguiton (2010) revisits her work on the DIYbio network, she focuses on 'doing DIY'. She proposes that doing as an amateur, meaning working outside the professional organization of labour, biology becomes a medium to express the pleasure of doing (Aguiton, 2010). The argument of pleasure is also taken up by Delfanti for whom hedonism is evidence that hacker culture is inspiring DIYbio members (Delfanti, 2010).

The relation with craft and artisan practices is also central to Sophia Roosth's work. She proposes that after the 'genetic fetishism' of the 1980s and 1990s,' we are witnessing the return of the biological as a crafted substance, and that the DIYbio network is an example of this return (Roosth, 2010: 14). While lasting only a chapter, Roosth's work greatly expands the interpretative framework through which to understand the DIYbio network. For her the DIYbio network is in a Foucaldian sense an *un*disciplined offspring of synthetic biology (2010: 113), a 'mode of political action'

claiming biology as a right rather than a privilege (ibid.: 105), a tinkering practice as described by Claude Lévi-Strauss (ibid.: 110), a 'recursive public,' as defined by Christopher Kelty in his studies of the Free/Libre/Open Source Software movement (Kelty in Roosth, 2010: 110), but also a 'frontier' where what it means to do science is questioned (Gieryn in Roosth, 2010: 110). Roosth's analysis of the DIYbio network as redefining the contours of scientific practice is endorsed by Kelty, who, in a brief publication, concludes that the publics composing and being gathered by the DIYbio network and related initiatives are 'aggressively active' and radically different from the 'public of opinion polls and scientific literacy' (2010: 8).

Concerned by similar questions on the relations between science and society, Joel Winston's Master's dissertation specifically describes the types of science communication and knowledge exchange practices taking place within the London Biohacking group (2012a). He concludes that biohacking widens the concept of citizen science and is a site where people with no formal education in science can learn more about biology. The notion of boundary work is also further explored in Morgan Meyer's work (2012a and 2012b), who, by situating the DIYbio network as part of an undistinguished continuity, including popular epidemiology, militant patient groups, patients associations and consumer engagement, concludes that what characterize the DIYbio network is the creative workarounds of tools and places resulting in the production of more permeable boundaries between professional scientists and amateurs. Stacey Kuznetsov's work is also focused on practices, and speculates about the creative opportunities that DIYbio offers to the field of Human Computer Interactions (2012). Another scholar particularly interested in the type of objects DIYbio members produce is Ana Delgado, who mobilizes Heidegger's political theory of things, in order to interpret the type of production of the new undertaken by DIYbio member (2013). She concludes that the mundane and immediate doing of DIYbio members illustrate how their doing produces things rather than techno-objects. Lastly, turning away from US and Europe-centred analysis, Denisa Kera (2012) explores the specificities of similar emerging practices in East-Asia. She argues that, rather than simply enabling 'rebellion or utopian wish-fulfillment' the practices she witnesses reconfigure indigenous practices and recent technological transformations.

If this literature review reads as a fragmented field, it is because these authors often write simultaneously, and only a minority actually cite and engage with each other's works. It seems that therefore, a recognized and coherent field of research has

yet to be established. Furthermore, this literature review illustrates that, up to now, the emergence of the DIYbio network, and the figure of the biohacker, have not been positioned as research subjects in themselves. Rather, as a subordinate case study, the DIYbio network makes several incursions in Master and PhD dissertations analysing broader cultural transformations in the life sciences. Additionally given the diversity of the analytical propositions made by these scholars, I wonder if such interpretative fragmentation mostly reflects scholars matters of concerns (as I am sure mine does) or actually also speaks about the DIYbio network as a composite culture deserving to be approached as a distinctive research subject. In relation to the issues raised in the literature, what concerns me primarily is how biology, and in particular biotechnology, are becoming material-semiotic fields for the self-fashioning of creative identities. I am interested, in particular, in how the categories of biology and biotechnology are being redefined and reconfigured through their practice as personal technologies.

The primary questions this research attempts to address are therefore: What does it mean to think of DNA as hackable, and biology and biotechnology as personal technologies? What biologies and socialities are produced in this process, and how can we live with them? While I recognize the exercise of formulating research questions, I am not claiming that mine emerged from the meticulous search of a grey zone in the literature. Instead I argue that the analytical specificity of my work consists in its double vantage of focusing on the DIYbio network as a subject in itself *and* of writing up at a time when I can think my data through, and in distinction with, the on-going interpretations that are being proposed by these scholars. In the following sections I present my methodology and outline the different chapters of this thesis.

Method

Having presented my theoretical approach and research questions, in this section I discuss how I proceeded to define and gather a substantial body of data. As this work traces the making of an international network composed of young and/or disenfranchised scientists through its discursive and material practices, I have adopted a qualitative and mixed methodological approach (Denzin and Lincoln, 2000). At this stage, I understand the need to use several methods, both as an attempt to match the composite nature of the field itself, and to gather rich data (Charmaz, 2006). But also as an ex-biologist-not-yet turned into a science and technology studies scholar, I felt the need to experiment with different methods in what had been often a disorientating,

but always an extremely enriching experience (see the Conclusion). Below I briefly explain how I have traced my fieldwork, and the different methods I used and how they allowed me to make certain arguments. I close the chapter by further discussing two major limitations of my approach.

Web 2.0 from a research tool to a virtual field

As discussed in the literature review, the first academic accounts of biohacking became available in July and August 2010 in the form of Ph.D. dissertations. My research did not therefore start by the delimit some under-appreciated questions in the academic literature to be then investigated in the field; instead, during this first period I spent most of my time on the Internet, running hundreds of searches with the aim of defining a field of inquiry. In the beginning, I exclusively depended on the identification and accumulation of descriptors by browsing the widest possible spectrum of websites where those terms were used. 'Hacking DNA' became the first descriptor, and I used Boolean search options from the private search engine Google™ to investigate some of its semantic possibilities (e.g. hack DNA, DNA hacker, and DNA hack). Each time the result of a query pointed me at an existing descriptor I would add it to my list and I ran new Boolean searches. I printed and archived these pages by date while recording on which web page those terms were used, by who they were used and which sort of activities were described through their use. It is through these searches that I came across the DIYbio network as one of the most prolific sites where these descriptors were used. Once I felt I had reached a group of stable and recurrent descriptors, I established four Google Alerts[12] for the most used ones: biohacking, biohackers, DIY biology and biopunk. Additionally, as I came across several mailing lists where those terms were used, I subscribed to the major ones: the main DIYbio Google Group, several local DIYbio Google Groups, the London Hackspace biohacking, the tmp/lab (Paris), and the Biocurious (USA) mailing lists.

The combination of these automatic descriptor-based searches produced an initial archive composed of both printed and digitally-saved web pages and blog entries, targeted mailing lists conversations, downloaded documents, videos, radio shows, and images associated with blog posts and newspaper articles or retrieved

12 Instead of running periodic searches using Google™, Google Alerts allows subscribers to a Gmail account, to define a sets of keywords and receive regular updates when these words appears as part of newly published web content.

from DIYbio members' photo-sharing websites such as Flickr™. This work has been informed by the emerging literature in the field of 'digital ethnography,' on how to analyse the web as a research field (Fielding, Lee and Blank, 2008). More importantly, this initial phase made me progressively aware that the members of the group I was interested in, were not simply 'on the Internet' but, that in their attempt to build a network of like-minded people, they skilfully used the Internet and in particular social media. Therefore, I also started to record an additional layer of information. Although I did not use any professional software to crawl the Internet, or to produce meta-analysis of social media, I kept a record of how content was cross-referenced among major websites, blogs and social networks. In doing this, what I gave particular attention to was how the making of biology and biotechnology into a personal technology was enacted using social media (see Chapter 3). The vast majority of this material was produced by two types of actors: the members of the biohacking community and both professional and freelance journalists. In addition, a relatively minor proportion of this material was produced by governmental and non-governmental institutions concerned with the biosafety and biosecurity risks that DIYbio might raise. Along those lines of research, I also progressively traced the emergence of a group of scholars interested in the DIYbio networks, mainly from the fields of science and technology studies (see previous section).

During the past three years, I have regularly conducted new searches on the Internet and updated my archive. Towards the end of my third year, and given how prolific DIYbio members are online, I opted for targeted searches aimed at examining specific themes or events. In the process of mapping the types of events that marked the emergence of the DIYbio network, the point where this research should reach its end became evident. The purpose of this work became to trace the emergence and the stabilization of the first home and community laboratories. As more and more groups formed, some initiatives succeeded in becoming a community laboratory while others dissolved. It is when a first group of community laboratories reached a certain type of organization and 'routine' that I decided to resume my fieldwork. This is not because the second phase appeared as less worth of scholarship or less personally appealing but simply because that would have made my research unmanageable both in term of time, scale and resources. Finally, this initial period of Internet-based research, allowed me to identify primary and secondary participants to be interviewed or contacted, sites to be visited, and events to be attended during my fieldwork.

Snapshots from transient and networked field sites

As this research is aimed at tracing the self-fashioning of an international techno-scientific network, I was bound to follow people, sites and events as they unfolded. One striking consequence of this approach is that the much discussed issue of the one how to engage with science-in-the-making (Latour and Woolgar, 2004 [1979]) has taken an additional dimension in my research. In effect, while I am writing these words, new DIYbio groups are establishing, some have ceased to exist, and other have re-formed after some time. To grasp this particular aspect of a science-in-the-making, I use the term 'transient practices,' and to reflect this aspect in my own writing I came to refer to my descriptions as 'snapshots' (for more on the transience of DIYbio practices see chapter five). My fieldwork is therefore characterized by short and intense periods of observation and participant observations lasting between couples of days to several weeks. These observations were complemented with more brief, event-oriented visits lasting several hours up to one day. It was during these visits that I recorded the majority of in-depth, semi-structured interviews with primary participants and had informal conversations with secondary participants. During both, I took field notes, pictures and recorded short videos. Despite the constraints both in time and resources, I attempted to visit as many significant sites for as long as possible, often rushing somewhere after having learned that a major DIYbio meeting was about to take place. My research is therefore, in the most direct way, multi-sited, and its structure attempts to reflect both the online and offline structure of the DIYbio network. The fieldwork started in London but led me to Manchester, Cork, the San Francisco Bay Area, Seattle, Los Angeles, New York, Boston, Copenhagen and Paris. As these visits were discontinuous and overlapping, I added a table where the places, types and length of those visits are listed chronologically (Appendix Three). More importantly, these visits have conduced me in a variety of sites, such as Hackspaces, privates homes, DIY and craft fairs, co-working spaces, and the Internet, thus rendering my work multi-sited in a sense first introduced by Marcus and Fischer (1986). Although these sites are situated in two major geographical areas, namely the United States and Europe, I did not intend to conduct a strict comparative analysis.[13] My interest actually focuses on the *networked* structure of the community. In particular, I use the term in reference to Fred Turner's work and his analysis of how the network – intended both as networked computers and cybernetic theories of non

13 Since, similar initiatives have sprouted in Asia and Oceania, for an introduction see the work of Kera (2012).

hierarchical and distributed organizations – enabled and became the models of new form of cultural entrepreneurship (Turner, 2006a). This practice is characterized by the establishment of online and offline gatherings among people crossing disciplinary and professional boundaries and the generation of rhetorical repertories and innovative forms of publication, in an effort to find an alternative to the bureaucratic mode of technocracy.[14] The network, in this sense become an organizational ideology aimed at enabling 'an nonhierachical, interpersonally intimate society' (Turner, 2006a: 249). It is in this sense, but also in reference to the fact that the term was sometime used by the participants to this research, that I came to call DIYbio, a network.[15]

Field site access and sample demography

As I was trying to gain access to a world composed of a majority of young adults and older adults, the large majority being highly educated, and white males, committed to openness, participatory and informal techno-scientific practices, only on extremely rarely occasions did I experienced being set apart. A couple of participants – one male and one female – clearly made me understand, they considered speaking with me as a loss of their precious time. I understood this not only as a reflection of the 'making' and 'hands-on' centric culture of the group, but also as a consequence of my appearance in the field either shortly after or simultaneous with the arrival of journalists, or even other scholars. These attitudes might also reflect an impression of often being asked the same question, an issue I will further engage in the next section on doing interviews. The only direct case of exclusion I experienced was when I was refused the permission to join the first meeting between DIYbio members and the FBI in New York. Special Agent Edward You refused my query on the argument basis that the meeting was for 'stakeholders only.'[16] The impression of being taken for a journalist was confirmed on several occasions. A couple of participants, before accepting to be interviewed, questioned me about the differences between my

14 Since the publication of Manuel Castells' work on the rise of the network society, the term 'network' is used to identify a much wider set of socio-economical phenomena characterized by the implosion of capitalist mode of productions with information theories and technologies (1996 [2000]). Yet, as Turner's explains, techno-utopianists paved the way for information theories and technologies to become 'ubiquitous and thoroughly integrated elements in our social and economic lives' (2006a: 249). In this sense, and in relation with the overlapping between Turner's actors and mines, I situate my use of the term in proximity of Turner's work, but within Castell's frame of analysis.

15 Across this dissertation, I use the term 'DIYbio network' to indicate a loose group of people, mainly interconnected by Internet mediated communication and sharing a number of common interests. In an attempt to reflect the role of these definitions, I will, as much as possible, use the term DIYbio network in relation to others used by the participants themselves. The most frequent are: the DIYbio community, biohackers and biohaking, and garage biology.

16 Quote from the e-mail message received from Special Agent Edward You on the 6 July 2011.

approach and that of journalists, while another participant decided to talk with me only when a friend and member of the DIYbio network had guaranteed him that I was not a journalist. The suspicion of being a journalist was particularly evident when investigating biosafety and biosecurity concerns. Participants perceived me as yet another person interested in the social and ethical impact of DIYbio and I often had to reiterate that my interest was in recording their understanding of these issues and that I was not searching to discover accidents, examples of malpractice, or to forecast risks. For these reasons I always scheduled an informal meeting before interviewing a participant, the other reason being a simple matter of courtesy.
For a summary of the socio-demography of the participants to this research, including indications of their educational status and professional position occupied at the time of the interview, as well as interviews dates and length, see Appendix Four.

Other than in these episodic cases, I did not feel as an outsider more than what I wanted to be one. I presented my self as a scholar in the field of science and technology studies, but if asked, I always disclosed my full educational trajectory, including my previous education in biology. In the context of a longer term relationship with the biohacking group at the London Hackspace, a couple of times, I had to clarify that I felt my role was not to advise them on which experiments were to be chosen. My refusal was motivated by the impression that my background in biology risked granting me a relative status of expert, and that this will put me in the awkward position of potentially impacting some of the group's choices. Having said that, I am aware that researchers inevitably influence the participants of their research. Finally, throughout the thesis I use the term 'young and/or disenfranchised scientists' to collectively qualify DIYbio. By using this expression, my aim is to grasp the composite motivational and biographical diversity of the DIYbio members. The term 'disenfranchised' is used in a attempt to capture a type of political consciousness in the making: one composed of few or several, explicit or implicit disagreements with the organization of scientific institutions. The underlying ambiguity is that in being disenfranchised, one does not need to be openly critical of the technoscientific enterprise itself. Similarly the term 'young' does not only refer to the average age of DIYbio members, which is between twenty-two and twenty-nine years old, it also and more importantly refers to their professional status as young scientists in the making. Such professional identities are inhabited by doubts, aspirations and partial understandings of the politics of the institutions they belong and/or drop out from.

Doing interviews

As previously mentioned, founders and iconic members of the DIYbio network have been frequently interviewed by journalists. When cited, their words all too often only participate in the sensationalism of the article itself. The choice of in-depth interviews came firstly from the necessity to capture the non-sensational parts of the DIYbio members' stories, meaning a narrative that was not the one constantly presented to journalists. To trace the experiments that did not work, the groups that formed and dissolved, their disagreements, but also to explore their reflexivity about the reality of their practices versus how they made themselves into one of the many success stories. My research criteria led me to the identification of an initial list of twenty-two primary and secondary participants. In conducting interviews with the first group of participants and during my participation in a variety of events, new participants were introduced to me. In total, I approached sixty one participants, forty-one were considered as primary participants and twenty were considered as secondary participants. The extent to which a participant considers oneself part of an emergent network such as the DIYbio, and how a participant might or not becomes a member will be described repeatedly in the empirical chapters. For the purpose of my methodology, I came to recognize primary participants as individuals who would explicitly self-identify as members of the DIYbio network, or who valued at least some of DIYbio network's aims, and regularly participated in national and international events, as well as being active locally by establishing private or collective laboratories or coordinating regular meetings. What I came to define as secondary participants were individuals who directly participated either by punctually providing inspiration, advice, or institutional leverage, or whose practices preceded the founding of the DIYbio network, although their work was unknown to DIYbio members. In the beginning, I also planned to interview people who were only active on the mailing lists, others who would participate in events hosted by DIYbio members, and researchers in academic institutions who would support or critique the DIYbio network. To my own disappointment this simply became impossible within the time and resource constraints of this research. I have interviewed thirty-three primary participants. Seven have been interviewed twice. The average length of the interviews is one hour and a half, with interviews ranging from one hour to two hours and a half. Additionally, I have had interviews and recorded informal conversations

with thirteen secondary participants. A total of seven participants did not respond to my e-mails, three of which were primary participants and four secondary participants.[17] When possible, interviews were conducted in person and were always preceded by an informal discussion or at least one face-to-face introduction of my research. The interviews took place in locations always chosen by the interviewee. These included Starbucks™ (presented as 'almost my office'), bars, private houses and laboratories, start-up offices and workplaces, community laboratories, Hackspaces, and sci|art galleries and venues. When a face-to-face meeting was not possible, interviews were conducted and recorded on Skype™. A total of twelve interviews were recorded on Skype™, seven of them were second-time interviews, while for the remaining five interviews I had previously met face-to-face with the interviewee. Three additional interviews that I draw on here, one involving two agents of the FBI, a second involving a member of DIYbio Paris with whom I had previous informal conversations, and a third with Kavita Berger from the American Association for the Advancement of Science, were designed in collaboration with Sara Aguiton, a Ph.D. student at Science Po Paris. She very kindly recorded and fully transcribed them.[18]

With each interview, my approach was to proceed inductively, using semi-structured interviewing. The interviews were both tailored according to the information that I had previously collected on each participant and organized around the following six key inquiries:

(1) How participants came to know and participate in the DIYbio network and how they would describe their role and contributions to the group.

(2) To which public or 'DIYbio only' events had they participated, and what did these events meant for them?

(3) What sort of tools did they construct, repair or source (this included reagents) and in which sort of experiments were those tools used? More generally, what type of experiments did they carry out and where?

17 Although I had a long informal discussion with Cowell Mackenzie, he did not return any of my e-mails concerning meeting for an interview.

18 This was an agreement we reached as part of a collaboration (Aguiton and Tocchetti, forthcoming).

(4) How do they organize their work in non-professional laboratory spaces and how do they solve problems they encounter, in particular problems related to biosafety concerns?

(5) How do they understand the biosafety and biosecurity concerns that the media and lately the government demanded to be addressed?

(6) What was their experience of their relationship with the media?

As I progressed, I re-worked and adapted my basic questions and themes to the changing field. On the other side, I also became aware that DIYbio members were very skilful at public relations. For this reason, quite counterintuitively, I came to drop the question of 'what is DIYbio?' as interviewees almost gave me letter-for-letter the same answers they would gave to journalists. This even if they had not been interviewed by journalists yet. Instead, I decided to question what they meant by using certain terms to define DIYbio. Similarly, as, since May 2011, the relationship between the members of DIYbio and Special Agents from the FBI became an important element in the constitution of the network, I rescheduled as many interviews as possible with participants who attended these events and added questions aimed at investigating this relationship. All, but four interviews were recorded, and in three of those cases the participants preferred to answer questions in writing while the fourth participants desired not to be recorded but only paraphrased. All the participants gave me full disclosure rights on their names and professional affiliations and signed the consent form (see Appendix Two). When it was not possible for them to send me a signed version of the informed consent form I recorded their consent as part of the interview. Only one person asked me not to cite the names of the companies for which he worked. All interviews and conversations were conducted in English. Although the non-native English speaking participants were all fluent English speakers, I paid extra attention to the formulation of my questions. Being myself a non-native speaker, I also mentioned it to the participants and at several times during the interview, assured myself that both native and non-native English speakers' interviewees understood my questions.

This phase resulted in a total of thirty-three recorded interviews with primary actors. Five were fully transcribed, producing a document or approximately 40'000

words while the remaining have been selectively transcribed resulting in documents of an average 3'000 words each. Additionally, I entirely or partially transcribed video and audio recordings of presentations given by DIYbio members, radio programs on which they appeared or recordings of workshops that they organized. In order to analyse the transcripts, I used several established techniques like manual coding, re-writing portions of interviews under broader themes like: 'becoming a member,' 'individual and community laboratories,' 'favourite experiments' and 'scientific legitimacy.' These are standard techniques detailed in qualitative research methods literature (Atkinson *et al*., 2011).

Finally, my fieldwork notes resulted from the amalgamation of several materials: (i) comments and observations that I would write while visiting private and community laboratories, such as their location and their organization, (ii) anecdotes collected during my participant-observations, and (iii) more traditional ethnographic fieldwork notes in which I would write about daily observations and activities (however, due to the discontinuity of my fieldwork it was not always possible to use such method). These notes were also analysed using the common qualitative analysis methods (Emerson *et al*., 2011).

Visual culture

Similarly as the Internet unexpectedly became an important field site, I became progressively aware of the importance of visual material, both in terms of videos and pictures produced by DIYbio members, and by more mainstream outlets. In total I gathered more than forty short videos, as well as dozens of pictures. The vast majority were uploaded on the Internet by DIYbio members while a chosen minority was published on newspaper's websites. Targeted analysis of this material was done using classical methods of visual discourse analysis (Gillan, 2011). In particular the type of questions guiding my analysis were: Where was the picture or video made? Who is in the picture or video and how is their role represented? Which elements are visually highlighted (tools/attitudes/places)? What is the illustrative role that the picture plays in the article? Which representations of biology and biotechnology are conveyed?

For the videos, particular attention was also given to the form (narration/editing/visual effects). The videos and the pictures produced by DIYbio members were even more important as they were used as means of self-promotion and

communication, as part of the still- growing video- and picture-sharing culture over the Internet. At the same time, this material, or at least a part of it, was produced as an explicit exercise in scientific documentation and outreach, particularly when members were attempting to portray their activities as accessible to everyone. Because I came to understand those practices as blurring the way in which the matter of visualization has been addressed in the field of history of science and, more recently, in the one of science and technology studies (Fox Keller, 1995), with theories of visual culture in media and cinema (Russell, 1999), I attempted to establish a method informed by both analytical positions. One that would enable me to understand the implosion of laboratory practice with the culture of making and disseminating short videos using the Internet. Again, similar questions regarding the visual material produced by the media were asked and supplemented with additional questions such as: Where was the picture or the video uploaded? Was it embedded or used somewhere else? At which occasion were pictures and videos taken? This material was particularly useful when analysing the role of mediation in the emergence of the DIYbio network (See Chapter Three).

Limitations

Although I already mentioned some of the major methodological limitations in the corresponding sections. Here, I would like to briefly describe two additional difficulties I encountered. In doing so, I partially relay on the foundational reflections proposed by Hammersley and Atkinson (1995), but mostly I try to figure it out (what I call) being an ex-biologist-not-yet-turned into a science and technology scholar. In particular, this has produced to two major issues: learning how to do fieldwork versus actually doing it, and what I came to call 'going un-native.' In respect of the first issue, doing fieldwork is a practice as any other, in the sense that as much as I have prepared by reading about methodologies, theories and practicalities, this literature only became fully meaningful after having been on fieldwork. For instance, despite having prepared each interview, I learned that it requires exercise to remain open and attentive to participant's narrations, while at the same time being focused on my questions. Similarly, it is only in the act of transcribing interviews, but even more in writing up my chapters, and going back and forth between my interviews and notes, and my writing, that I begun to see the larger picture. For instance, my interviews were heavily centred around the type of practices DIYbio members engaged with. It was only once I

finished my offline fieldwork, that I became explicitly attentive to the uncertainty of most participant's professional status, or their disenfranchisement with their educational or professional experience as a theme to address directly. In thinking back at my posture, I clearly remember feeling embarrassed about asking more, as if unemployment or uncertainties regarding one's own future were a 'stigma.' I even, naively felt relieved when participants would steer the conversation back to enthusiastic descriptions of the projects they where involved in. This issue ties with the broader issue of how to engage with transient practices, in the sense of taking seriously their transience in relation to the social-professional uncertainty of the actors practising them (see the second section of Method).

The second major limitation I would like to briefly address, relates to what I came to call 'going un-native.' The term is borrowed from Latour and Woolgar's discussion of how going native entails accepting scientist's descriptions of their own work at face value (2004 [1979]). Having started my research as a trained biologist, I learned – after having repeatedly returned from an event, with no field notes in my field notebook – to progressively let go of a certain sense of internalized immediate understanding, and to acquire another posture of comprehension. Having said that, as I was not familiar with most of the practices involving the writing software codes or the building of electronic hardware, the way I reported about their observations enabled me to reconsider what I felt more familiar with. It is by moving back and forth between these feeling of educational, but also personal, familiarity that I have attempted to situate and question my practice of comprehension.

Conclusions

I started by presenting two rather old and yet peculiarly evocative newspaper articles as glimpses of a trope under formation. This trope, I argued, is one of home made DNA, and of biotechnology as the next personal computer revolution; its central figure is the bio-hacker. I went on by briefly proposing that the formation of the DIYbio network is an important case study to question the attempt of making these tropes into a new biotechnological world, and I argued that such formation can be understood as part of the debate on the implosions of informatics and biologics. After having reviewed the major elements of this debate, I suggested that scholars' analysis of the computer (as a metaphor, a model and a machine) has moved away from its reduction to a vehicle of determinism, towards the characterization of hybrid and recursive

relations to the biological. Nonetheless, I argued that even the most recent literature, concerned with borrowings from the open source software movement, does not situate how a politics of freedom, decentralization and empowerment, which accompanies the computer, might perform when borrowed to make sense of life.

I suggested that the notion of digital utopianism developed by Turner is helpful because it captures the cultural legacies that made the personal and networked computer into a revolutionary spokes-technology: a technology that would bring to life the ideal of a decentralized, egalitarian, harmonious and free society (2006a). While Turner's notion is historically important, I paused to consider how necessary it is to constantly question how freedom and democracy are imagined in the digital technologies and the life sciences. Especially, as Reardon has expressed it in the case of genomics, both digital technologies and the life sciences seek to become relational technologies (2013). I concluded by suggesting that one of the most recent and significant borrowings is the one occurring between a reconfigured version of digital utopianism and the life sciences. In reference to the utopian legacy of the personal computer, I coined the temporary term of personal biology to grasp the socio-technical visions and practices that the members of the DIYbio network are experimenting with. By presenting the emerging academic literature on the DIYbio network, I described the interpretative spectrum elaborated by scholars and I argued that despite its diversity, the formation of the DIYbio network has not been retained as a subject in itself. As a consequence, the discourses and the practices of the DIYbio network are abundantly conceptualized but poorly situated within the specific institutions, economies and technologies that shapes and organize them. In the methodology section, I outlined the method I used to gather and analyse a substantial body of data.

As Haraway summarized it, the role of the cultural critic is to look at the production of modern culture by 'pull[ing] on a thread and entangle the ball of meanings and trace through one thread and then another, what gets to count as nature, for whom and when and how much it costs to produce nature in a particular moment in history, for a particular group of people' (Haraway, 1987). In what follows, faithful to Haraway's advice, I pull on the threads of the DIYbio network, and I try to cope with the mess of meanings that comes with the emergence of personal biology as a form of nature-under-production. Framing each chapter as a specific moment in the making of biology into a personal technology, this thesis is

composed of four themes: the self-fashioning of a user-friendly biology, the making of a personal biology, laboratories on a shoe string as a techno-utopia-in-the-making, and the good biocitizen as a figure productively embracing a more 'democratic biotechnology.

Thesis Outline

This section maps out the content of each chapter as part of an interlocking narrative that is aimed at investigating what does it means to make biology and biotechnology into a personal technology. Similarly to the way in which the pieces of evidence collected during the fieldwork are both partially bound to follow a linear chronology and at the same time reveal a multitude of networked hybridization that resists such chronological purity, the overarching arguments in this thesis are organized both in a linear and a recursive manner. By following this structure, the purpose of each empirical chapter is to momentously suspend, describe and theorize an element of the DIYbio network's culture, as it oscillates between its discursive promises, and its transient or stable practices. At the same time, each chapter is written in a way that incorporates the theme analysed in previous chapter. For each of the six chapters, especially the empirical ones, the intended effect is to diffract the argument made in the preceding chapter, while presenting and discussing a further element of how the members of the DIYbio network turn biology and biotechnology into a personal technology.

Chapter Two

One of the aims of this work is to illustrate that the DIYbio network can be sociologically characterized as a distinctive composite organization: an assemblage that is not only greater than the sum of its parts, but that is also the result of a very specific type of work aimed at re-configuring biology as a personal technology. In such a context, the exercise of providing a literature review separate from the empirical chapters seems particularly artificial, especially when the process of selecting pertinent literature did not occur before, but has mostly happened at the same time as, interpreting and situating the empirical work itself. Additionally, a review is rarely balanced and invariably represents only a part of what has been written on a certain subject. Yet, for the sake of the inevitable limit to the scope of this work I have

selected only a few themes and texts which I believe are pertinent for my research. The areas and debates that are addressed here are: (1) sociological and anthropological studies of computer hackers; (2) historical and sociological studies of amateur and citizen science; (3) the historical study of public essays and laboratories studies. If throughout the chapters I rely specifically on the work of other authors, the literature review provides a broader context in which I locate my work.

Chapter Three

In chapter three, 'Technoscience in hypertext: biology as a relational technology,' I beg in my empirical discussion by revisiting the well-trodden ground of the origins of the DIYbio network. If scholars have interested themselves in the way that DIYbio memb ers used the Internet to purchase second hand material, raise funds, or give each other advice over mailing lists, my interests lies in how social media and its personal and par ticipatory technologies were instrumental for DIYbio members to learn the skill of sel f-presentation. By first looking at how the DIYbio co-founders came up with the term 'DIYbio' and also at how they met each other, I tell the story of how the neologism be came a semantic space in which to imagine personal genomics and synthetic biology b ecoming accessible to everyone – this space that was first stabilized in the form of a w eb domain. This first snapshot is briefly informed by Haraway's understanding of com puters as trope (1997), and by Anke te Heesen's work on notebooks as a paper technol ogy to gather people (2005). In the second snapshot, I focus on social media. Followin g Haraway's proposition that hyperlinks are a technology of realization, I look at social media as a place where DIYbio members made themselves as much as they created the ir socio-technical vision of a personal biology. In particular, I look at how DIYbio me mbers use blogs, and how these turn biology and biotechnology into yet another form of web content. I use the work of Dominique Cardon and Hélène Delaunay-Teterel on how blogs enable identity making (2006), and in particular I use their figure of the pro fessional-amateur blogger to frame what I provisionally call the making of a user-frien dly biology.

Chapter Four

In chapter four, 'The making of a personal biology,' I move from the self-fashioning of DIYbio members' identities online to describe one of the places where their ideal

community could exist offline. To do so, I take a rather long detour and situate the formation of the DIYbio network within part of a networked forum called 'The MAKE.' By considering members of the DIYbio network *also* as makers, this chapters questions how it became possible to think and practice biology and biotechnology as a personal technology. The first snapshot traces the figure of 'the maker' by following, through elements of their biographies, the motivations of the founders of *Make Magazine*. The first snapshot shows that several elements of the socio-technical vision promoted in the magazine can be traced to a late version of the American digital utopianism and to the techno-libertarian pragmatics of the *Whole Earth Catalog*. This legacy is strengthened by being combined with the cultural resurrection of the maker, a figure embodying the reassuring myth of grassroots American innovation as a natural source of endless entrepreneurial opportunities. In the second snapshot, I argue that the inscription of biology as a material and a tool part of *Make Magazine*, and the increasing attendance of members from the DIYbio network at Maker Faires, contributed to the understanding and the practice of biology as personal. In particular, I trace the circulation of laboratory practices from the professional world of science communication, to the projects described in *Make Magazine* and the use of these same projects as part of the formation of the DIYbio network. The chapter concludes by discussing how the identification of DIYbio's members with the figure of the 'maker' participated in the composition and the stabilization of a specific socio-technical vision of a personal biology.

Chapter Five

In chapter five, 'Reality Check: The hobby of turning biotropes into bioworlds,' I further question what it means and what it takes to stabilise the practice of biology and biotechnology as a personal technology. If some of the activities that DIYbio members engage in have been briefly presented in the previous chapters, in this chapter I question what types of work the members of the DIYbio network are actually doing. In particular, my interest lies in the understanding of how a socio-technical vision addressing, among others, young and/or disenfranchised scientists can be turned into a different practice of biology and biotechnology. In particular, I argue that the transience of these practices reveals the precarious financial or professional condition of the practitioners, but it also reveals the uncertainty of their

epistemological and empirical proposition. In the chapter, I follow Cathal Garvey, a prominent member of the DIYbio network based in Cork, Ireland, as he presents to me his laboratory on a shoe string located in a room of his parent's house. By following him, I question what it means to enact a certain critique of technoscience in the form of an empirical practice. The first snapshot portrays Garvey as he problematized the political economy of contemporary biotechnology. His dissenting attitude towards a technoscience increasingly poisoned by commercial values, called upon the necessity to put biotechnology into people's hands as a solution – a task that he sees as his. I therefore pursue the description of Garvey's laboratory as an empirical reflection of his attempt to put biotechnology into the hands of the people.

Chapter Six

In the sixth and final empirical chapter, 'On being good biocitizens: ethics as a process' I pursue my understanding of the socio-technical vision of a personal biology by looking at how the members of the DIYbio network produced a code of ethics. The chapter is framed by another identity-in-the-making – that of the 'good biocitizen.' In following the preparatory phase of the DIYbio European Congress, and in particular by following the role of Jason Bobe, DIYbio co-founder, as a community director. I argue that policy making became just another type of making that the members of the DIYbio network needed in order for their socio-technical vision to thrive. I then continue by tracing the course of the DIYbio European Congress as a case study to look at the making of the good biocitizen. I do so by progressively paying attention to the recorded reactions and emotions of the participants, including my own in the role of an ex-biologist-not-yet turned into a science and technology scholar. My commitment is to gain an understanding of the way in which the organizers enacted ethics as a process in the form of a visionary and participatory workshop, as well as to understand my surprise and discomfort when I found myself to be part of such an event, where the writing of a code of ethics was presented as a process. I conclude by arguing that, enacted as a process, ethics fails to address participant's emotions and reactions. Those emotions and reactions, I argued, included a strong sense of meaning well about the world. A feeling which, I argue, is indicative of a way young scientists could come to experience the imperative of being useful and helpful via the specific act of providing 'technological solutions.' I proposed that ethical relating, as a

contradiction, might be an occasion to collectively share the necessity and uncertainties to enterprise oneself up under the pressure and the excitement of having to provide solutions for 'the world' and 'the people.'

Conclusions

This chapter draws on the themes and discussions addressed throughout this thesis and provides an overarching critical reflection on the notion of personal biology. The themes this chapter draws upon are: the self-fashioning of a user-friendly biology, the making of a personal biology, laboratories on a shoe string as a techno utopia-in-the-making, and the good biocitizen as a figure productively embracing a more democratic biotechnology. Before reconsidering these themes, I propose a biographical snapshot of myself in the role of an ex-biologist-not-yet-turned into a science and technology scholar. In doing that, I locate myself within the political tradition of the radical science movement. A movement which development is entangled with one of the field of science and technology studies. From that standpoint, I look back at DIYbio members as a group of young and/or disenfranchised scientists whom, I argued, have found in the techno-utopia of a personal technology a tool to elaborate their disagreement about different aspects of contemporary life sciences.

1. Literature review

Introduction

Defined through the use of chimerical neologisms, DIYbio and biohacking emerged from the reconfiguration of a specific sub-set of pre-existing cultural practices. In particular, the vitality of the network in-the-making depends upon the capacity that the members have to assimilate and knit together a number of diverse discourses, practices and actors. To remain faithful to such composite genealogy throughout my literature review, I proceed by locating such pre-existing cultural practices within concerned fields of literature. In this sense, my research therefore draws upon subject matter that has been proficiently addressed by academics in the fields of history, anthropology and social studies of science and technology. These fields of literature provided me with a discursive and analytical mirror in which I could confront the material that I collected during my field work. More generally, such composite literature provided a conceptual framework within which I could further situate my interpretations of the work done by the members of the DIYbio network in the process of turning biology into a personal technology. As the composite nature of the DIYbio network embodies the practice of composite self-fashioning, my contribution, I argue, resides in the juxtaposition of these fields of literature.

In the introduction to my thesis I located my research within an area of the literature in the field of science and technology studies that is interested in understanding how researchers have been using computers as metaphors, models, or machines to make sense of life. In this respect, I proposed that within such literature the work has been done with computers the life sciences has mostly been understood as occurring at an epistemological or empirical level. However, I proposed that when the computer is considered as personal and networked technology it additionally provides a techno-utopia, and that the DIYbio network is an important case study to understand how such techno-utopia is used to make sense of life. I also said that while during my research I encountered some of the actors and the institutions central to the making of the computer into a personal technology, digital utopianism and the trope of the personal computer cannot be considered as a fixed and all-inclusive analytical category. In this respect, and in reference to the work of Jennifer Reardon (2011 and 2013), I proposed a first departure from digital utopianism as a fixed analytical

category – a departure that is marked by the commitment to constantly question how freedom, democracy are imagined as biology becomes a personal technology. Following on from that, in the introduction I also located my work within the emerging literature dedicated to the DIYbio network. In doing so, I discussed the similarities and differences between my work and a literature that became available as I was carrying out my own research.

Against this background, the aim of this chapter is to further expand my review of the academic literature in order to provide a composite and preliminary analytical framework suitable for this research. To do so, I engage with three major fields of academic literature that address, in my view, pre-existent cultural practices which have been reconfigured within the DIYbio network. These are: sociological and anthropological studies of computer hackers, historical and sociological studies of amateur and citizen science, and the historical study of public essays and laboratories' studies. The second part of this literature review is particularly challenging for me to write as it attempts to justify the choices of a certain literary trajectory without mobilizing evidence from the field work that would make these choices intelligible. In the context of this research, the presentation of the literature review as a preceding and preparatory stage is therefore, to a certain extent, a formal fiction. If, for instance, areas of the literature, such as sociological and ethnographic studies of computer hackers, have from the very beginning been recognized as significant, others, such as the historical study of the formation of the 'amateur scientists' in Victorian science, have surfaced only in the course of my field work. To explain such choices, each section begins with briefs references to my own field work observations, and continues with a review of influential works in the given areas.

In the conclusions, I discuss how the combination of these areas of the literature constitutes the preliminary conceptual foundations of this work. The in-depth interpolation of the literature, the fieldwork observations and the interview analysis is carried out in dedicated empirical chapters. Similarly, other relevant works are directly used in chapters rather than as part of this literature review.

Social and anthropological studies of Hackers, F/LOSS and the Web 2.0

In the process of self-fashioning their identities and socio-technical vision, the members of the DIYbio network have extensively drawn from what is commonly known as the computer hacker's culture. The most direct example is the use of the composed neologism 'biohacker,' and the reference to specific inspirational tales in the

history of information technologies, such as the tale of the Homebrew Computer Club and its members. While referring to these mythical moments, sites and figures in order to narrate the origin of DIYbio and biohacking, members of the network also circulate within a specific portion of what could be named the 'contemporary hacker culture.' This portion is a much wider and more diverse assemblage of which the free software and open source (F/OSS) movements are a major component. More recently, networks of so-called Hackspaces have also started to become referential sites for DIYbio activities. Finally, biohackers are also proficient users of Web 2.0 technologies such as social networking (e.g. Twitter and Meet-ups), video and picture broadcasting services (e.g. Youtube, Vimeo and Flikr). In an attempt to address the historical references to computer hackers, as well as the contemporary reconfigurations of digital culture cited above, this section of the literature review will only sketch major traits of the hacker culture. More specific and situated works from relevant academics will be considered in conjunction with fieldwork observations and interviews. The broad question guiding this section of the literature review survey is: how have academics described the emergence of computer hackers, the F/LOSS movement and the use of Web 2.0 networking technologies?

Computer hackers and the F/LOSS movement

Computer hackers and information technology technophiles, or 'geeks,' are considered a 'vernacular culture,' a group characterized by an existence 'entirely dependent on digital technologies' and and whose study is part of the broader field of digital studies (Coleman, 2010a: 492). The first account of computer hackers' culture, entitled *Hackers: Heroes of the computer revolution*, was published in 1984 by journalist Steven Levy (2010 [1984]). Thanks to what have been praised as vivid and detailed descriptions, Levy's book has since become a classic for several generations of technophiles in search of genealogies, but also for early academics interested in the history of computer hacking. Levy's book is particularly known for having established the first chronological distinction of hacker types into three generations. The first generation is mainly constituted of undergraduate research students orbiting around the Artificial Intelligence Laboratory at MIT in the 1950s and 60s. The second generation is composed of college drop-outs and members of the counterculture mostly located in Northern California during the late 1960s, and the latest generation is characterized by the 'young game hackers' of the early 1980s (2010: vix). Despite

such typology, the emergence of the socio-technical vision marking the first generation of computer hackers has not received a lot of attention. An exception is the work of Fred Turner, who calls for us to 'turn our collective attention backward' (Turner, 2006b: n.d.). In his work, Turner stresses the necessity to articulate the study of emerging forms of social life sustained by the Internet with the critical insights gained from the historical analysis of the role played by the counter culture in the composition of the discourses and practices of the computer hackers and more generally the 'digital generation' (2006b).

A second major contribution of Levy's work is the extrapolation of the 'hacker ethic,' which he describes as a set of aesthetic and ethical principles that value information access, sharing and decentralization, meritocracy, and a belief that computers are a means of expression and a tool to improve the world. These principles have since become referential for academics and computer hackers alike. Nevertheless, Gabriella Coleman, an influential anthropologist of computer hackers, refers to the influence of the concept of an 'hacker's ethic' as the 'Achilles heel of journalistic and academic studies of hackers.' (Coleman, 2010b). She argues that by mobilizing these principles in an over-simplified manner, many scholars have ended up masking the moral complexity of computer hackers practices (Coleman, 2010b). However, interestingly enough Levy's work on hacker ethics was not taken into account by his contemporaries in the field of sociology.

Synchronously with the mainstream media and government agencies in the 1990s, early sociological studies of hackers in fact portray them as deviant and pathological individuals (Gilboa, 1996). Those claims were quickly criticized by subsequent works which responded by analysing the social construction of the hacker as a deviant. Drawing from Benedict Anderson's work on the concept of nation, Tim Jordan and Paul Taylor proposed a description of computer hackers as an example of an 'imagined community' (Anderson, 1991 cited in Jordan and Taylor, 1998: 19). Based on interviews, these authors investigated how a technical gesture gains or loses the status of a 'hack,' as well as the moral principles and motivations of hackers as characterized by explorations rather than criminal intentions. They also addressed the fluidity of computer hacker groups membership, the ambiguous relation between secrecy and bravado, the misogyny of its members, and the negotiation of the community boundaries with respect to the Computer Security Industry. By highlighting how hackers reflexively discuss their motivations, social organization and

culture, Jordan and Taylor's work already describes a cultural trait that Christopher Kelty, in his study of F/LOSS movements, partially reinvented under the name of 'recursive publics' (Kelty, 2008). Taylor's work also analyses how, in an attempt to establish their own professional identity, members of the computer security industry, whose founders often were 'ex-hackers,' supported the claims that hackers were deviant individuals (Taylor, 2001). The role of politicians in stigmatizing computer hackers as deviant subjects was studied by Taylor during the implementation of the first anti-hacking legislation in the 1990s (Taylor 1999 and 2001). Finally, Amanda Chandler (1996), Stephen Rosoff, Henry H. Pontell and Robert Tillman (1998) have de-constructed the role of the media in portraying hackers as deviant, obsessive and criminal individuals. In respect to the three generations outlined by Levy, these authors mainly focus on the third, separating computer hackers from the history of information technologies. Moreover, their interest is the social construction of an emerging identity, rather than the specificity of computer hackers' technological practices.

Following this first period, in which social scientists' research claims were mostly based on interviews and analysis of 'outsider' discourses (e.g. the media, governments and the computer security industry), the study of hackers moved towards a more situated, experience-driven and practices-focused approach. This movement has to be understood as part of a larger critique happening in other areas of information and computer technologies studies. In particular, by reconsidering the role of the user, anthropologists of online communities illustrated that the hyped understanding of the Internet as an autonomous technology inducing social change should be reconsidered (Miller and Slater, 2000). Ethnographic encounters based on online and off-line fieldwork and in-depth interviews with 'insiders' re-dis moi ciao ciao marked a departure from the sociological approach. Additionally, with the development of the ICT sector into a booming economy, the focus of these studies moved from the analysis of an exotic sub-culture, to the cultural significance of an emerging socio-professional category. Early ethnographic studies include Kelty's fieldwork investigations of how computer software acquires the status of commodity and how its value is negotiated (2001). By describing free and open source software communities, where hundreds of software engineers collaborate without written contracts or formal hierarchies, his work also investigates how, with respect to networks of computers, work is organized, the engineers' reputations are established, decisions are taken, and solutions are proposed (Kelty, 2001). Additionally, Coleman

and Hill also stresses the importance of both online and off-line contexts and criticize the moral Manichaeism whereby hackers are lauded or denounced (2004). In particular, Coleman and Golub (2008) use hackers as a case study to explain the anthropological account of liberalism in our societies. They propose a moral typology of computer hackers marked by acts of civilian disobedience that are enacted by: i) the development and release of software technologies that were previously only available to military and private corporations, ii) the act of political inversion, such as the overturning of copyright law into law that protects the sharing of software, iii) the capacity of transgressing power that one might acquire from understanding a digital technology much better than most of the technology's users, these being individuals, governments or private corporations (Coleman and Golub, 2008). In the work of James Leach (2005), the practices of sharing computer code and software have also been analyzed as a contemporary version of Marcel Mauss gift's economy; in this context, sharing of software is understood as a practice aimed at establishing an intellectual common ground (Marcel Mauss, 1924 cited in Leach, 2005). One of the latest and most inclusive ethnographic works on the Free and Open Source Software (F/OSS) movement is Kelty's *Two bits* (2008). In this work, he recapitulates the emergence of the F/OSS movement, arguing that one of the main characteristics of, and reason for, its success is that hacker communities are recursive publics: 'publics concerned with the ability to build, control, modify, and maintain the infrastructure that allows them to come into being in the first place and which in turn, constitutes their everyday practical commitment and the identities of the participants as crere-dis moi ciao ciao ative and autonomous individuals' (2008: 7). Although Turner's work on the history of the ideology that shaped the emergence of the personal computer and cyber communities (2006a) is mentioned in Coleman's reviews of digital studies (2010a), Turner's work on the connection between the migration of counter-cultural techno utopianism on the Internet, and the second and third generation of computer hackers, goes surprisingly unmentioned. For instance, if in their work Coleman and Golub meticulously articulate hackers' practices with respect to different liberal traditions (2008), they somehow miss the historical implosion of scientific communalism and counter-cultural libertarianism and its role in the development of the computer as a personal technology (Turner, 2006a). This comment is meant as a reminder of the difficulties in locating the specificity of present practices while at the same time untangling the contingent conditions of their making. Recent developments in the literature on computer hacking include early studies of the emergence of the 'hacklab' and Hackspaces movements (Grenzfurthner and

Schneider, 2009 and Maxigas, 2012). If the computer's hacker movement as an historical reference and a present site plays an influential role in the self-fashioning of the members of the DIYbio network, part of their doing so is also more broadly located within more mainstream uses and cultures of digital technologies.

Web 2.0 and social media

The resurgence of discourses on the Internet as a participatory technology are related to recent developments of what is referred at as the Web 2.0[1]. As for other emergent technologies, early works have either endorsed the participative ideology of the Web 2.0 (Weinberger, 2007 and Shirky 2008) or contested its liberating promises (Mosco, 2004). For an examination of popular discourses on both the '(new) worries and doubts voiced by the alarmists and the (new) hopes and dreams portrayed by the enthusiasts' see for instance Pak-Hang Wong (2013). Once the discursive effect of hype dissipated, more situated works analysed how users engage with these tools and which forms of participation are actually enacted through them. These first observations include the emergence of 'microcelebrities' due to the practice of Webcasting (Senft, 2008) and the mapping of twitter uses (Marwick and Boyd, 2010). The mythologised history and the contemporary sites of computer hackers' culture are not the only sites from which members of the DIYbio draw their inspiration while building their community. The following section continues to review the academic literature by addressing three other pre-existing cultural practices that are inspirational for the members of the DIYbio network.

Victorian amateur scientists, modern amateurs and citizen science

While promoting their activities or explaining them to the media, members of the DIYbio network often refer to themselves, and in an interchangeable manner, as 'citizen scientists,' 'science amateurs' and/or 'hobbyists.' They also claim to engage in science outreach activities in order to propose alternatives to the educational approach proposed by mainstream science institutions. If their participative practices are inspired by the hands-on ethos of computer hackers and F/OSS communities, biohacker also refer to Victorian scientists and their eclectic professional and personal trajectories as an ideal of a more creative and inclusive model of scientific inquiry. The understanding of how citizen scientists, science

1 A neologism recognized as having been coined by Dale Dougherty, co-founder of O'Reilly Media Inc. and *Make Magazine*'s Editor and Publisher, who in his role as the founder of the maker movement will be presented in Chapter Three.

amateurs and/or hobbyist are used as synonyms by biohackers, requires to first revisit the distinctions that academics have drawn between amateur science, modern amateur science and citizen science. Similarly to the previous section, and due to the composite nature of the DIYbio network, my aim is to engage with a specific sub-set of authors and not to summarize the current state of the literature in each of these fields.

To do this, the first section attempts to retrace the major themes organizing the way in which the discourses and practices of amateur science have been analysed in the academic literature, in particular the historical role of amateurs in the formation of modern science. Yet, rather than considering amateur science as a group in itself, I will follow a strand of literature that discusses amateur science practices alongside other types of amateur practice and more broadly with questions addressed in the field of leisure studies. My reason for this is to connect the question of amateur scientists to the question of scientific labour, not in the context of the emergence of modern science but in the context of a more recent past.

Next, I offer an analysis of citizen science and attempt to highlight how, according to the academic literature, distinctions and continuities can be drawn between modern amateur scientists and citizen scientists. The broad questions guiding this section of the literature survey are: how have academics described the figure of the Victorian amateur, and how have academics described the figure of the *modern* science amateurs and how does this literature distinguish these figures from the practice of citizen science?

History of Victorian amateurs and sociology of modern science amateurs

An early and important attempt to investigate the formation of amateur science is undertaken in Morris Berman's study of the amateur tradition in British Science (1975) where he traces Britain’s delayed evolution from 'pure science' to its obtaining a mature professional status. Berman's account of amateur science situates its emergence at the beginning of the nineteen-century and its decline with the emergence of the professional scientist in the late 1870s. Bergman's aim is to depart from Kuhn's theorization of revolutionary changes in science as motivated by internal methodological and theoretical aspects of scientific practice, and instead to 'start discussing scientific change in terms of categories common to the writing of all good

history: social structure, class conflict, ideology, psychological motivations and the like' (1975: 31). Drawing on Antonio Gramsci's concept of cultural hegemony, Bergman describes how science practices, as an amateur, was 'just another facet of the cultured gentleman's repertoire' (ibid.: 35). He suggests that similarly to how throughout the 19th century the lifestyle of the aristocracy remained a hegemonic model for the emerging middle-class, the figure of the amateur scientist deeply characterized the British scientific community in-the-making. He writes 'the tradition of the wealthy amateur pursuing scientific research at his leisure was an ideal because of its association with the aristocracy and 'proper' way to live, and proven to be the single greatest constraint on Victorian attempts at scientific professionalization' (ibid.: 36). The amateur scientist was a member of more or less prestigious scientific academies. The part-time or full-time work of the amateur scientist was supported by aristocrats, members of the middle-class with a similar mentality to his, or his own funds. He was free to follow his own individual theoretical and experimental interests. Barman argues how, quite contradictorily, the hegemonic life style of the aristocratic amateur actually guaranteed the epistemological freedom that made possible the work of particularly innovative individuals – the 'string of brilliant names' that characterized Victorian science (ibid.: 48). Berman's argument is particularly interesting when situated in the continuity of Steven Shapin's study on the pre-scientific identities in the sixteenth and seventeenth century, his work on the history of the scholar and the gentleman, and his work on the co-construction of the ideals of nobility and knowledge (1991). Conversely, by focusing her analysis on the field of botany, Anne Sercod challenges historians' focus on the role of the middle-class in the development of modern science and describes the practice of science from the point of view of working class members such as artisans and manual workers (1994). After the golden period of the19th century, the term 'amateur science' fades away from the academic literature on science. In the literature covering the beginning of the nineteen-century until the end of the Second World War, the figure of the amateur scientist is marginal; academics' interest shifted from the modes of formation of modern science to its transition toward an institutionalized science and the study of the increasing political, social and economic leverage acquired by science as a mature profession (Merton, 1973 [1942]).

The study of science amateurs re-appears in the late 1970s, particularly in the

work of sociologist Robert A. Stebbins, who coins the term 'modern amateurs' and carries out the first studies of recent forms of amateurism (Stebbins, 1977). In his work, amateurs are considered to engage in a specific cultural practice whose characteristics and significance are studied as part of the field of the sociology of leisure, or 'leisure studies' (Stebbins, 2006). The originality of Stebbins' approach is that his studies are longitudinal rather than historical (i.e. his observations are trans-disciplinary and transcend the sphere of science), a methodological posture that allows him to compare amateur practices between music, sports, dance, cooking and science. Stebbins identifies five major types of amateurs: collectors, makers and tinkerers, activity participants, players of sports and games, and enthusiasts of the liberal arts. His overarching definition of modern amateurs describes them as marginal participants in the professional-amateur-public triangulation, whose identities are constructed in line with the identity of the respective professionals (Stebbins, 1992).

Additionally, to account for the emergence of the leisure industry, Stebbins establishes an interesting distinction between amateurs engaged in 'serious leisure' and others involved in 'causal leisure.' According to his observations, serious leisure is characterized by perseverance and personal effort in the form of rehearsal, practice or study, and systematization. The practice of serious leisure is described as an activity that results in durable benefit, such as renewal of the self and a sense of accomplishment. He also claims that such practices are associated with the emergence of a unique ethos and a strong identification not only with the activity in itself but also with the practitioner's social, professional and economic surroundings (Stebbins, 1992). Causal leisure, on the other hand, refers to an ensemble of activities that necessitate little or no training and effort in order to be appreciated.

Finally, Stebbins describes becoming amateur in terms of choice, emotional drive, and vocation. According to his findings, one is not coerced into becoming an amateur, nor is being an amateur perceived as a particular form of oppositional or critical practice (Stebbins, 1992). More specifically, his work on modern science amateurs, which he alternatively names 'avocational scientists,' focuses on archaeology, astronomy and ornithology, and questions the composition of the relationship between professionals and amateurs. In a comparative study of amateurs and professional astronomers, Stebbins argues that the relationship between amateurs and professionals can be understood as the combination of several traits:

> 1) amateurs serve publics [i.e. pro-actively organize events for the public, such as talks, encounters with professional scientists and special visits]; 2) a monetary and organizational relationship exists between amateurs and professionals; 3) intellectual ties bind these two groups; 4) amateurs restrain professionals from overemphasising technique and from stressing superficialities in lieu of profound work; 5) amateurs insist on the retention of excellence; 6) amateurs simulate professionals to give the public the best they can; 7) professionals start their careers as amateurs (1982: 434).

More recently, the work of Susan Leigh Stars and James Griesemer (1989) has demonstrated how in a museum the work of a diverse group of actors, including amateurs, professionals and administrators, is made possible by what Stars and Griesemer have termed 'trading zones' and 'boundary objects.' Those are objects that are understood and used differently by different groups, but, as they are necessary to the maintenance of each group's identity, they act as sites of passage and encounter. At the same time, they do not prevent each group from maintaining allegiances to their respective fields. In the following section, and in relation with how DIYbio members use these terms as synonyms, the figure of the Victorian and the modern amateur scientist are considered in the recent context of citizen science and lay knowledge practices.

Citizen science and lay knowledge studies

As biohackers use the terms 'amateur science' and 'citizen science' as synonymous, in this section I will attempt to illustrate how the terms of amateurs and citizen scientists are actually used by academics to describe two distinct, though sometimes overlapping, sets of practices.

A first set of distinctions separating Victorian amateur sciences and modern amateur science, have been described in the previous section. In particular, the term modern amateur science is used to refer to a person whose relationship to science is characterized by the desire to participate in, and contribute to, a certain field by producing work that is valuable to the professional scientists in the respective fields (e.g. amateur astronomers and astronomers). Only in very rare cases, as Stebbins notices (1992), do amateurs actually criticize the empirical or epistemological work carried out by professional scientists. In this respect, the figure of the professional scientist is esteemed and his/her recognition is yearned for by the amateur.

Citizen science groups, on the other hand, are more commonly understood as an organized source of counter-expertise to the expertise promoted by professional scientists. Although their members might recognize the value of scientific work in support of their cause, they strive to gain recognition due to the fact that they are being stigmatized, ignored or inadequately represented and or served by specific professional science practitioners and experts.

The term 'citizen science' itself was coined by sociologist Alan Irwin, who used it to regroup an increasing set of practices challenging the understanding of how scientific expertise is accepted or rejected (1995). For instance, sociologist Brian Wynne coined the term 'lay expertise' as a critique of the lack of consideration that professional scientists have for lay knowledge and experience that members of the public developed and mobilized to cope with techno-scientific externalities (Wynne, 1992). To illustrate his point he explained how sheep farmers responded to scientific advice about post-Chernobyl restrictions by refusing to blindly-trust the experts and instead mobilizing their wealth of local knowledge (Wynne, 1992). Related to this is another early study by Phil Brown which describes groups of 'popular epidemiologists' whose members were engaged in civic actions and who learned how to gather epidemiological data on water pollution in the attempt to further efforts to treat and prevent diseases caused by toxic waste and to establish communal, independent and factual evidence about the issue (Brown, 1992). Similarly, Vololona Rabeharisoa and Michel Callon's work investigates how patient associations have claimed their right to participate in the design, funding and structure of research projects (Rabeharisoa and Callon, 1999), while Steven Epstein's work has highlighted similar modes of knowledge and practices of co-construction in the context of AIDS activism (1995). More recently, David Hess offered an historical overview of how the environmental activism movement, with limited resources and by experimenting with local solutions, influenced or failed to influence an increasingly global and corporate-driven research agenda (2007). By focusing on the grey zone between local activism and 'the mainstream,' and between industrial opposition movements (IOMs) and product-oriented movements (TPMs), Hess traces what he calls the incorporation of practices and their role in the transformation of science and technology (2007).

The previous sections of the literature review have been compiled with the intention to identify a number of academic works with which to reflect on the

emergence of the DIYbio network. The selected areas of the literature particularly engage with the construction of identities, questioning where members of DIYbio draw their inspirations from. Yet, a major part of the work that members of the DIYbio network are doing is experimenting on how to turn these discourses into practices, in particular by making certain strategies of intervention on 'living matter,' developed within technoscience, available to everyone.

History of public experiments and laboratory studies

The places where these claims are made into practices are called community laboratories, but they are also made into practices during transient public demonstrations that members of the DIYbio network organize as part of science festivals, DIY fairs or farmers' markets. In order to situate my study of the practices and the forms of life that biohackers are producing, two additional areas of the literature in the field of Science and Technology Studies appear as particularly pertinent. These are the study of the notions of 'laboratory' and public proof in the history of science, and the role of laboratory work in defining a scientific practice developed by academics in the field of laboratory studies. The broad questions guiding this last section of the literature are: how have academics described the history of public experiments and, in contemporary scientific practices, how do academics understand the laboratory as a place of production? How can we understand the role of public experiments in contemporary science outreach and communication practices?

Assays and Public Proof

In the introduction of a recent study on the historical formation of scientific proofs, Simon Schaffer illustrates how the recent debates on GMOs unleashed natural scientists' nostalgia for the time when scientific expertise was simply accepted. He notes that sociologists also celebrate, although for opposite reasons, the fact that such times are gone, and concludes that both the natural and the social scientist emerged from the debate as supporters of a historically misleading impression that such a time of acceptance had actually existed (2005).

To counter those claims, and disembroil this dichotomy of regimes of trust and doubt, Schaffer proposes to look back to the history of what he calls 'public experiments.' He describes how, during the 18th century, public experiments were often

a 'postprandial trials of virtue' for the aristocracy (2005: 303). Assayers who relied on sophisticated, highly visible, spectacular and authoritative social scenography not only competed to provide the most convincing solution to a mathematical, physical or astronomical problem, but at the same time offered solutions to problems of political order. An illustrative example is Otto Von Guericke's ingenious demonstrations of how a man, by mastering air and pressure, could exercise a power superior to that of one hundred men. Such proof was retained both as a scientific fact and as a political statement about power. Assays, Schaffer argues, were forums where 'public things' were disputed and where natural and political proof was orchestrated as part of the same ritual performance (2005). Similarly, in recapitulating the controversy that brought Boyle in opposition to Hobbes, Shapin and Schaffer pause on the fact that Boyle believed in the concept of the 'open laboratory' and regarded 'modest witnesses' as an essential element for the establishment of proof, something which Hobbes rejected. If the technical device and the demonstrative bravura of the assayer were orchestrated, so was the composition of the audience (1985). In her critique of the social construction of the figure of the 'modest witness,' Haraway, who names those same public experiments 'theatres of persuasion' (1997: 25), expands on Shapin's analysis of the regulation of the public space and its composition. Haraway acknowledges that in a later work Shapin questioned the 'covered' persons and the absent ones (Shapin, 1994 cited in Haraway, 1997: 26-28), but she also argues that Shapin's work does not address "whether and how precisely the world of scientific gentleman was *instrumental* in both sustaining old and crafting new 'gendered' ways of life" (ibid.: 28). What Haraway points by highlighting the relationship between the demographic composition of such forums and the type of knowledge that was produced in, and disseminated by, them is what she calls the 'gaze from nowhere' (ibid.: 188) as a distinctive trait of the participatory promise of early Victorian science. Keeping with the metaphor of the theatre, this last section moves away from the historical stages of public proof, towards the study of modern laboratories as the backstage of contemporary scientific work. Accompanied by Haraway's description of laboratories as 'breeding rectors,'[2] this section asks: which insight do laboratory studies

2 The term is used both by Haraway, (1997: 55) in her discussion of the transgressive practices involved in the production of transuranic elements, and by Robert Kohler to describe how the mutation of drosophila flies in Morgan's laboratories generated new material for the researchers to study (1994).

offer about scientists at work?

Laboratory studies

The field emerged in the late 1970s with the intention to study the production of scientific knowledge in-situ, to observe science in the making. Early findings marked a clear departure from both philosophers of science who authoritatively neglected the importance of social and cultural context, as well as historians of science who understood context and locality as a derivative of the history of ideas (Hess, 2011 [2001]). By opening up the laboratory and its opaque practices, sociologists and anthropologists demonstrated that scientific experiments were not only methodologically and technically, but also symbolically and politically, constructed and assembled.

Latour and Woolgar's study exposes the laboratory as a place where, through technical manipulations, negotiations, alliances and tactics, scientific facts are 'inscribed,' where inscription is defined as a procedure that strips away human agency and allows the scientist to claim that he has made some objective observations (Latour and Woolgar, 2004 [1979]). Michael Lynch's ethno-methodological approach highlights how researchers 'get rid' of artefacts and 'errors,' and through conversation analysis he explains how agreements and disagreements are settled (Lynch, 1985). Susan Traweek's comparative ethnography of US and Japanese high energy physics laboratories shows how careers are shaped, how mentorship is practised, and how researchers' experimental ideas of time and space shape their own social organization of work (Traweek, 1988). More specifically, in respect to the transformative space of the laboratory in the life sciences, Michel Callon develops the notion of 'translation' to show not only how it is that in laboratories humans and non-humans become entangled, but also how these entanglements produce forms of lives that become the centre of new interests and practices (Callon, 1986). Among the most salient examples is the way in which the study of model organisms generates additional materials for study (Kohler, 1994 and Landecker, 2006) or, more generally, how 'creativity breeds creativity' (Kelty, 2012: 6). Other studies of 'laboratory bench work' have empirically demonstrated that science does not unveil or explore a factual reality that would simply 'be there' independent of the science, but instead science practices what Knorr Cetina calls the 'homing in' of the laboratory of natural processes, and the study of those 'homing' processes reveals science to be a cultural practice (1999).

While these studies are concerned with finding out what a laboratory is and what happens in a laboratory, by engaging with the networked circulation of techno-breeded lives which she calls 'cyborgs,' Haraway's work is of great help to imagine diffracted kinship structures as loci for a situated critique of technoscience (1997). Her feminist, multicultural, anti-racist technoscience project stands as an overcrowded and swarming shelter when the multi-faced genealogy, composite economy and radical participatory ideal of the DIYbio network becomes too credible (Haraway, 1994).

Conclusions

In this chapter, I have tried to establish the foundations for an empirical discussion that follows from exploring how what I identify as the pre-existing cultural practices composing the DIYbio network have been addressed in the academic literature. This is an attempt to compose an interlocking conceptual framework that will allow me to situate the cultural reconfigurations that establish DIYbio as a distinctive techno-scientific network.

While it is possible to justify the preliminary choice of these areas of the literature, in the absence of empirical observations it remains difficult to show how the analytical concept elaborated in this literature can be mobilized. At this stage, this literature operates as a point of comparison through which I recursively circulate when attempting to understand the significance of a certain cultural trait that I recognize within the DIYbio network. The specificity of the discourses and the practices of the members of the DIYbio network is their composite and chimerical makeup that they produce in their attempt to establish a different practice of biology and biotechnology. The insight gained by each of these comparisons is therefore insightful but limited. For instance, the sociological and anthropological studies of computer hackers and F/LOSS initiatives guides my analysis of the discursive, material and practical trafficking between the computer hackers, F/LOSS initiatives and the DIYbio network; but their analytical strength dissipates when DIYbio members engage in public experiments and science communication practices. Similarly, the historical studies of Victorian amateur gentleman and modern amateur scientists enable me to situate the ideal of science to which DIYbio's members refer to when they explain what type of ideal representation of science their practice is inspired by. But the insight gained from

this literature is limited when used to understand how the work of 'community laboratories' is organized, and how to make sense of the empirical practices DIYbio members engage in. Addressed throughout the empirical discussion to come is the articulation between the composite discourses and practices of the DIYbio network, and a composite conceptual framework built upon literatures organized around what, at the time, were distinguished fields of literature.

2. Technoscience in hypertext: biology as a relational technology

We sent out this e-mail saying, 'Hey, community, we're really interested in do-it-yourself biology. We're not sure what that means yet. Here are some ideas about what that could mean. Let's get together and figure it out.'

MacKenzie Cowell, DIYbio co-founder, on Public Broadcasting System, 30 December 2008.

Introduction

This first empirical chapter opens with the answer that MacKenzie, one of the co-founders of the DIYbio network, gave to a journalist questioning him about DIYbio's origins. MacKenzie recalled sending out an e-mail to the 'community.' In it, the co-founder expressed uncertainties regarding the meaning of the term do-it-yourself biology, and excitement at the idea of figuring it out together. The starting point of my first empirical chapter is the use of e-mails as a technology to gather like-minded people in order to figure out what 'do-it-yourself biology' means.

Scholars interested in the emergence of the DIYbio network have either situated DIYbio as nesting in the 'off scenes' of the iGEM (Aguiton, 2009 and 2010) or more broadly as an *un*disciplined offspring of professionals in the field of synthetic biology (Roosth, 2010). Others have proposed that the idea can be traced to the writing of Robert Carlson, a physicist turned techno-visionary, consultant and garage biologist, who, in 2005, wrote in a notorious technology magazine that 'the era of garage biology is upon us' (Wired, cited in Delfanti, 2010). Taking the risk of over-studying DIYbio's origins, I return to this well-trodden ground with a slightly different question. Given MacKenzie's answer, my interest lies in the role played by the Internet, and in particular by social media, in the figuring out, as well as in making, of the DIYbio network.

Having said that, within the literature on the DIYbio network, the fact that DIYbio members use the Internet is not a new observation. Delfanti proposes that DIYbio is an example of 'peer-to-peer science,' a mode of production enabled by 'web tools [that] are creating and facilitating new ways for lay people to interact with scientists or to cooperate with each other' (2010: 35). He continues by explaining that 'the Internet has changed the way of collecting, sharing and organising the knowledge

produced by people — peers — who do not belong to the established scientific community' (ibid.: 35). Despite being well grounded in theory, Delfanti's description only mentions that DIYbio members buy second hand laboratory equipment and reagents on the Internet. Acknowledging Delfanti's theoretical proposition, and arguing that the phenomena further blurs the gap between science and society, Joel Winston remarks that the actors studied in his fieldwork use the Internet to 'access scientific papers, lab protocols, Wikipedia and other websites for theory' (Winston, 2012a: 33). Other scholars have also noted that DIYbio members use crowd-funding[1] initiatives to raise funds to cover some of the costs of community laboratories and the making of cheap laboratory instruments (Meyer, 2012 and Delgado, 2013). Finally, briefly describing the 'Google group listserve' – the central mailing list of the DIYbio network – Roosth (2010) describes the ongoing conversations. These conversations include advice on how to 'conduct biology experiments at home, where to find cheap equipment, and how to build inexpensive versions of expensive lab equipment' (Roosth, 2010: 121). According to Roosth, the listserv also provides a forum where DIYbio members share protocols, post links of interests, and argue about a range of topics such as regulation of lab safety in amateur communities, proper list etiquette, and how 'members of the group should present themselves and formalize the aims of the group' (ibid.: 121) She concludes the section by writing that 'Biohackers want to master the technical laboratory skills inculcated in apprenticeship-based lab pedagogies (though not the myriad other oratorical and textual skills of self-presentation that successful scientists must learn)' (ibid.: 121).

The argument at the core of this chapter builds on these works, but takes a slightly different direction. As I became more familiar with my research subject, DIYbio members appeared as fluent users of social media. Not only do they communicate via mailing lists and discussion groups (mostly Google Groups™) and coordinate meetings using Meet-up® and Facebook® services, they also recurrently express themselves on Twitter™, and use Youtube™, Vimeo, Flikr™ or SlideShare® services to share a diverse range of content including pictures, collages, videos, and PowerPoint presentations. Following the DIYbio co-founders' use of e-mails as a technology to gather like-minded people in order to figure out what 'do-it-yourself

1 The practice of funding a project or venture by raising many small amounts of money from a large number of people, typically via the Internet, Online Oxford Dictionary.

biology' means, this chapter proposes that social media and its personal and participatory technologies were instrumental for DIYbio members to learn the skills of self-presentation: skills that, while still oratorical and textual, also became 'multi-medial' and hyper-textual. In the uncertainty of establishing their socio-technical vision, DIYbio members found in social media a place where they could collectively self-fashion their identities, and they found a tool to elaborate, immortalize and disseminate the socio-technical vision of a do-it-yourself biology. I conclude by proposing that even if, at least in our neoliberal and globalized societies, social media has become a mundane technology of the self, in the case of the DIYbio network its semiotic-material infrastructure as come to additionally sustain the promise of a biology and a biotechnology available to all. This, I propose, is possible insofar as the socio-technical vision which is central to social media – aimed at further enabling distributed and non-hierarchical forms of online and offline communication and production – strongly resonates with the socio-technical vision that DIYbio members are attempting to realize with respect to biology and biotechnology. In saying this, I am not arguing that biology and biotechnology are becoming 'more digital' (Tacker, 2004 and Zylinska, 2009), or that, as suggested by the authors presented in the previous paragraph, the Internet *simply* enables the access, the sharing and the organization of knowledge pertaining to these fields. Rather, as the title of this chapter suggests, my reading of how DIYbio use social media is informed by Haraway's metaphorical use of hypertext as a technology of realization. Haraway writes that as

> computer software for organizing networks of meaning of conceptual links, hypertext both represents and forges webs of relationships. Hypertext actively produces consciousness for the objects it constitutes. [...] Helping users to hold things in material-symbolic-psychic connection, hypertext is an instrument for reconstructing common sense about relatedness (Haraway, 1997: 125).

If hypertext is now mundane and assimilated as part of social media, Haraway's proposition is still relevant to think at how, "As any good technology does, [social media] 'realizes' its subjects and objects" (ibid.: 125).[2] It is in this sense that I am interested in how social media *realizes* the DIYbio network.

The chapter is divided into two main sections. It begins with a first snapshot where I tell the story of how DIYbio co-founders came up with the term 'DIYbio,' and

2 In the quote, to illustrate my point, I have substituted the term 'hypertext' used by Haraway, with the term social media.

how, as a neologism, the term became a space where to imagine personal genomics and synthetic biology as becoming accessible to everyone – a space that, I argue, was first stabilized in the form of a web domain. This first snapshot is briefly informed by Haraway's understanding of computers as trope (1997), and by Anke te Heesen's work on notebooks as a paper technology to gather people (2005).

In the second snapshot, I further look at social media and in particular at blogs as a technology of realization.[3] If I decided to focus my interest on personal and collective blogs it is because in blog posts the web content produced by DIYbio members, and the social networks where this content is circulated, are both visible. In particular, I begin by describing the filling up of DIYbio's central website, its programmatic statement and the making of the main DIYbio logo and posters as foundational stages in the making of the DIYbio network. This second snapshot continues by analysing the content of several blogs. The examples which I am drawing upon are the central web site diybio.org, and the blogs of four community laboratories: Genspace, based in New York; Biocurious, based in Sunnyvale (California); La Paillasse the regional 'community laboratory' based in Paris; MadLab based in Manchester (UK); and the personal blog of Cathal Garvey, an early and very active member based in Cork (Ireland). This second snapshot is informed by the work of Dominique Cardon and Hélène Delaunay-Teterel on how blogs enable identity-making as a relational technology (2006), and particularly their work on the figure of 'pro-ams' as a professional-amateur identity that constitutes itself through the maintenance of a blog (Cardon and Delaunay-Teterel, 2006).

First snapshot – Prototypes, proto-tropes and the self-fashioning of DIYbio co-founders

Jason Bobe is considered the co-founder of the DIYbio network. In our interview, he described his educational and professional trajectory as marked by the desire to become a doctor, then a scientist, then a philosopher, then an historian of science and ending up, as he said, being 'none of them and all of them.' In 2007, after attaining a bachelor's degree in molecular biology, a master's degree in information system and dozens of extra curriculum classes, Bobe made a spontaneous job application to

3 Throughout this chapter I will use the terms 'blog' and 'website' as synonyms. This choice marks an attempt to convey the increasing similarities in terms of functions and software architecture between blogs and websites.

Professor George Church, the founder and director of the Personal Genome Project (PGP) at Harvard University.[4] He was immediately hired as the Director of Community for PGP. Bobe explained to me that it was his passion for personal genomics and the job description that he wrote over lunch that convinced Church to take him on.

Having worked for two years as a business consultant for Ryan Phelan, – a social entrepreneur and founder of DNA Direct and a pioneering personal genome firm based in San Francisco[5] – and being a fervent supporter of the idea that access to personal genome information is a right and should be a shareable resource, Bobe was well prepared to become an advocate for the PGP. It is while Bobe explained to me the story of the term DIYbio, that the significance of his workplace took on an additional dimension. Working for the PGP, Bobe told me, he would often wander through the laboratories. There:

> I was witnessing, in George's lab, the DNA sequencing devices getting smaller and faster and cheaper. And they have basically done a totally DIY sequencing instrument called the Polonator [...] You went in this little room and there was this microscope that was totally taken apart and wires coming in and random looking pieces of hardware plugged in and they had basically converted this microscope into a sequencing device.

He continued:

> This was going to be cheap enough for everybody to have one of these devices in the garage, and they wanted one soon, and I was looking for how to call it.

4 Founded in 2005 and designated by Church as the 'natural successor' of the Human Genome Project, the PGP is based on volunteers who, after several steps of an 'open consent,' make their sequenced genomes and phenotypes data public via the Internet (Angrist, 2012).

5 DNA direct was founded in 2005 and it promotes the ideal of a personalized medicine based on access to DNA data. Available at <http://www.dnadirect.com/dnaweb/about-us/about-us.html>. Last accessed 27 July 2013.

Figure 2.1 The Polonator on Flikr.

In the picture George Church presents the prototype of the Polonator to visitors.[6]

The fabrication of *ad hoc* research tools and their adaptation to experimental requirements and explorations is a common characteristic of many research laboratories.[7] Bobe's quote suggests an additional purpose of such laboratory craft. In his narration, the Polonator's prototype is not only a DNA sequencer built out of a microscope, but also the first sequencer cheap enough for everybody to have one in their home or, more precisely, in their garages. What Bobe was searching for was a name for the instrument, although in his phrase 'it' might as well refer to the revolutionary socio-technical promise bounded to the Polonator. In describing the process of finding a name, Bobe followed up by jokingly referring to himself as a 'white boarder.' He mentioned that after seeing the Polonator he plunged into a brainstorm session:

> So the idea is that I was looking for how to call it and I wanted a short domain and I wanted bio to be in there and what, something like really short, really small and DIY was the name that came out of that. This was a brainstorm session, just me and the paper.

6 Available at <http://www.flickr.com/photos/90082709@N00/6872966019/in/photostream/>. Last accessed 13 July 2013. The picture is a screen shot from the Flikr account of Steward Brand, a founder of the Long Now Foundation and a visitor to Church's laboratory as part of a collaborative project aimed at reviving extinct species using synthetic DNA technologies. Available at <http://longnow.org/revive/passenger-pigeon-workshop/>. Last accessed 13 July 2013.

7 See, for instance, the work of Susan Traweek (1988), and Paul Rabinow's (1997). For a similar argument extended to the field of synthetic biology, see Roosth (2010).

The term he came up with was DIYbio, a short name that could also be used as a domain (an Internet domain). Bobe concluded his story by saying that he immediately purchased the corresponding Internet domain: DIYbio.org. That was in February 2008.

Following Haraway's understanding of computers as tropes, in the sense that they are 'metonymic for the articulation of humans and nonhumans through which potent 'things' like freedom, justice, well-being, skill, wealth and knowledge are variously reconstituted' (1997: 126), I read the role of the sequencer's prototype in Bobe's narration to be that of a proto-trope. A discursive tool that enabled Bobe to understand personal genomics as sequencing, not only as a service to be made available to all, but as something that anyone could do on his own, in the entrepreneurial space that is one's own garage[8]. What the proto-trope is set to reconfigure is the relationship between the powerful prefix '-bio,' with the equally generative acronym of 'DIY' for 'Do-it-Yourself.' The neologism DIYbio is the result of Bobe thinking *with* a technology, the Polonator, but also of using a technology to think: brainstorming. The so called 'creativity technique,' developed by North American advertisement agents,[9] does not enable Bobe to produce something out of nothing, but rather makes it possible to assemble something that is more than the sum of its parts. By doing so, Bobe opens-up a semiotic space to be inhabited: a space whose first stable form is, at that moment, a dormant Internet domain.

Not far from Bobe, another person was, in his own way, figuring out the upcoming era of a biology more available to everyone. As I could not interview Cowell MacKenzie, the other co-founder of DIYbio,[10] I chose to use the Internet to find a biographical entry for him. There, under the username '100ideas,' MacKenzie has a Twitter™ and a Tumblr™ account.[11] '100ideas' is also the domain name of MacKenzie's personal, though dormant, blog.[12] While under the username 'macowell,' he has a Youtube™, a Vimeo™, and a Flickr™ account. The username '100ideas' suggests that MacKenzie identifies himself with his creative capacity to come up with hundreds of ideas, a few glimpses of which he published on his personal blog.

8 The garage as the site of American innovation, is an organizing trope for DIYbio members (see next chapter). Since, the term has also been picked up by DIYbio members located in Europe.

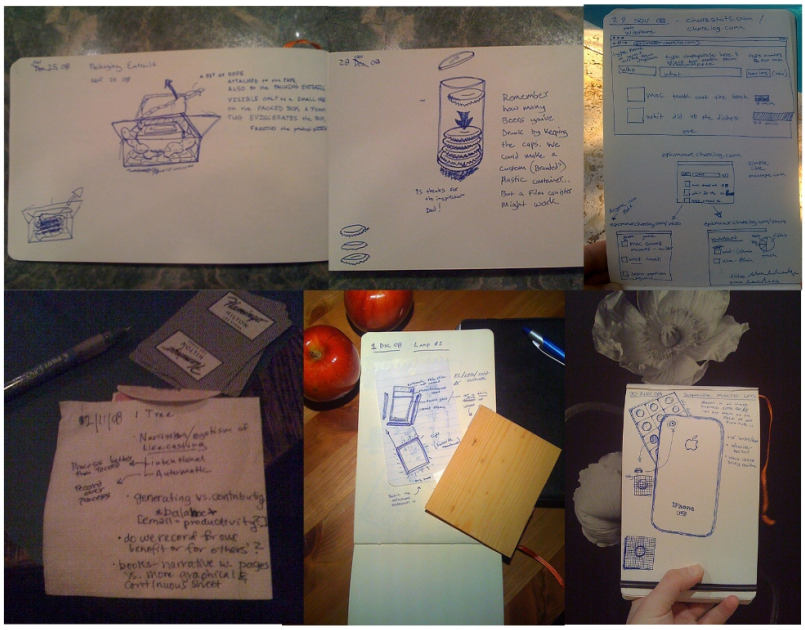
9 The technique was developed by Alex Osborn, with the aim 'to induce people to put their imaginations to greater use, to get them to produce more and better ideas for our clients' (Appelgate, 2000: 293).

10 See the Methodology chapter.

11 Like Twitter, Tumblr is a microblogging platform, However, Tumblr is oriented toward visual, rather than textual, content.

12 Available at <http://has100ideas.com/>. Last accessed 18 June 2013.

Figure 2.2 Stream of prototypes.



In clockwise and chronological posting order: 'Packaging Entrails' (posted on November 28, 2008 at 7:41pm), 'cap canister' and 'chorelog.com' (both posted on November 29, 2008 at 12:28pm), 'disposable sticky lens' (posted on November 30, 2008 at 12:10pm), 'lamp no. 1' (posted on December 1, 2008 at 9:11pm), 'the purpose of personal records' (posted on December 11, 2008 at 4:49pm).

The image is a collage of several pictures posted without comments by 100ideas[13]. Together, they read like a visual stream of consciousness composed of different sketches of prototypes. All, at the exception of one, are product prototypes: an entrails-shaped packaging material; a canister designed to collect beer caps to allow its owner to remember how many beers he or she has drunk; chorelog.com – an online software aimed at keeping track of household chores in flats shared by different people; some disposable and coloured lenses for taking pictures with an iPhone; a design for a wooden lamp; and a napkin recording a reflexive conversation on the aim of the 'personal record' itself. The drawings are completed with arrows indicating the movements of the prototype's components, instructions on how to assemble it,

13 Available at <http://blog.genefoo.com/page/11>. Last accessed 18 June 2013. Genefoo is also the name of the company that MacKenzie is currently running. 'Foo' stands for 'Friends Of O'Reilly,' a term designated by Tim O'Reilly, the CEO of O'Reilly Media Co., to name the Foo Camp, an annual un-conference hosted at the company's headquarters. An un-conference gathering is a gathering which explicitly avoids all formal aspects of a conferences such as a program set by the organisers, sponsored presentations, and is generally considered a participant-driven meeting.

suggestions on the potential market and even acknowledgements of the people who inspired him.

In thinking of MacKenzie's stream of prototypes, I turn to what Anke te Heesen writes about the symbolic value of the notebook as a paper technology, and specifically how it is reminiscent of a 'modern artist' or a 'creative mind' (2005). Heesen explains:

> The notebook is a cultural technique, an encoded implementation of paper that does not belong exclusively to the private or the public sphere, to leisure or to work, to contemplation or communication. This object (medium) operates between these spheres and arouses notice an interest. The notebooks collects people (2005: 598).

I read Heesen in the context of understanding blogs as a type of media combining two previously separated services: auto-publication and collective communication (Beaudouin and Velkovska, 1999). If Bobe defined himself as a 'white boarder,' expressing his creativity in the production of a neologism, MacKenzie might prefer the term of 'online prototyper.' His blog, I propose, is the media where he can auto-publish and communicate his restless creativity in the form of pictures of his prototypes' sketches. The notebook, a paper technology, becomes digital, and MacKenzie's 100ideas become part of his relational making on the blog.

While this brief online biography might situate MacKenzie' relationship to his creativity, it is through his professional biography that he came to DIYbio. He has told the story in numerous interviews from journalists and scholars. MacKenzie's interest in a biology truly available to everyone, grew out of his educational and professional experience. After graduating from Davidson College with a bachelor's degree in Biology in 2007, MacKenzie participated in the iGEM competition and later joined the organization in a position that he defined as the 'gopher,' someone running around taking care of various small tasks.[14] At the Massachusetts Institute of Technology (MIT), MacKenzie was exposed to the 'hacker' culture that the founding fathers of synthetic biology infused the discipline with (Roosth, 2010). But in April 2008, MacKenzie quit the job. In an early interview that appeared in SEED Magazine, he is quoted as explaining that 'the honeymoon period of that job disappeared after a year or so. I wasn't learning new things.' The journalist wrote 'So Cowell did the obvious thing: “I sold the car and started DIYbio,”' although at the time he did not know the

14 Available on MacKenzie's Mendeley profile at: <http://www.mendeley.com/profiles/mackenzie-cowell/>. Last accessed 11 June 2014.

term DIYbio (Boustead, 2008). If Bobe was figuring out how DNA sequencers could become so cheap that everyone could have one in their garages, MacKenzie was concerned that the promise of a biology that was easier to engineer, fuelling the synthetic biology research agenda, would be available only to university students and academics. In the same interview he explained:

> I really fell in love with the general idea that biology can be engineered. But I was disappointed with the huge barrier of entry for average people, or for anyone who wants to get involved but is not already in a PhD program. The open-source computer-programming movement became ubiquitous, and computers became a platform that enabled a huge amateur or hobbyist culture of people to push the field further. Many people got organized and started working on projects collaboratively. So why can't we do that with biology? Why does all biology happen in academic or industrial labs? What's the barrier to entry for doing something interesting in biology? It's a four- to seven-year PhD program. There must be another opportunity.

If Bobe might embody the figure of someone who wishes to have a DNA sequencer in his own garage to get closer to his own biology, MacKenzie impersonates, at least for the journalists, another North American figure at the core of entrepreneurship's myth: the drop-out. Although the relationship between education and self-employment success has disproved that particular myth (Robinson and Sexton, 1994), MacKenzie's professional trajectory suggests that as biology is supposedly becoming easier to engineers, professional trajectories in the life sciences can be imagined through the figure of the drop-out.

Yet, despite their seemingly similar interests, working in the same area of the city of Boston and for related institutions, Bobe and MacKenzie did not know each other. Bobe explained to me that it was a third person, Andrew Hessel, who enabled their meeting. Hessel, who has been described as a 'biotech hipster — a professional life science provocateur' (Wohlsen, 2011) his described on his profile as the co-chair of Bioinformatics and Biotechnology at the Singularity University[15] as 'a futurist and catalyst in biological technologies, helping industry, academics, and authorities better

15 The Singularity University is an American institution hosted on the NASA Research Park in Silicon Valley. Guided by its founders' trans-humanist ideology of the imminent and exponential convergence of technologies (i.e. the name 'Singularity' came from this ideology) the university offers targeted private education in the emerging field of technoscience, including the management, acceleration, and organization of techno-scientific innovation.

understand the changes ahead in life science.'[16] During my interview with him, Hessel eagerly expressed his passion for enabling people with similar ideas to meet, and described the meeting of Bobe and MacKenzie as the 'necessary spark that lead to the first DIYbio meeting.'

Figure 2.3 The making of the DIYbio network: portraits.

In a clockwise order from top right: An early portrait of the DIYbio co-founders, taken as part of an article published in Nature Medicine and photographed on the MIT campus (Nair, 2009). A portrait of Andrew Hessel, from his current profile on the website of the Singularity University. A second portrait of Bobe, taken from his current professional Google + Account. And a second portrait of MacKenzie published in Le Monde (Eudes, 2009).[17]

Bobe and MacKenzie met at the Boston's Betahouse, a now closed co-working space for 'entrepreneurs, technologists and creatives'.[18] It is in this space that the respective 'figuring out' of Bobe and MacKenzie became a relation. A couple of weeks later, at

16 This is the first paragraph of a two paragraph profile available at: <http://singularityu.org/bio/andrew-hessel/>. Last accessed 16 June 2013.

17 The picture is only available in the paper version, an archived copy of which is available on demand.

18 Information retrieved using the WayBack Machine on the Internet Archive. Available at <http://archive.org/web/>. Last Accessed 16 June 2013. Co-working spaces are places that have become increasingly common in the creative industries where 'mobile professionals,' for a monthly fee, rent shared office space with other unaffiliated professionals working in related areas (Spinuzzi, 2012: 399). For and introduction on creative industries see David Hesmondhalgh's work (2002).

the end of May 2008, on several mailing lists an invitation to a meeting aimed at figuring out the meaning of a 'do-it-yourself biology' was circulated.

This first snapshot situates DIYbio co-founders. They appear as self-aware, creative and enterprising mobile young professionals, circulating within, or claiming to drop out from powerful scientific institutions. They rub shoulders with influential scientific figures in the field of personal genomic and synthetic biology and their encounter is mediated by a person who defines himself as a futurist and a technology catalyst. Their creative minds are busy figuring out what needs to be done to make the next technological frontier in biology accessible to 'average people' so that a large group of individuals can work collaboratively to push the field forward. In their process of figuring out, DIYbio co-founders used thinking technologies, such as brainstorming and blogs, as digitalized notebooks. Their first product is a neologism stabilized in the form of a dormant Internet domain: a neologism that, mediated via a mailing list, became the term used to address the very group whose members were supposed to figure out its definition. As MacKenzie phrased it: 'let's get together and figure it out.'

Pursuing the description of the self-fashioning of the DIYbio network, the next snapshot asks: what sort of creative place of production is an Internet domain? By looking first at the structure of the central DIYbio website, then at the production of the logo of the network, and finally at the production of web content and in particular blogs, I trace how in the Internet and particularly social media, DIYbio members found a place where they could collectively elaborate their identities, and a tool to immortalize and disseminate their vision of a do-it-yourself biology.

Second snapshot – social media as a relational technology

As Bobe explained, the first realization of DIYbio was in the form of an Internet domain name composed of the chimerical neologism DIYbio, the signifier '.' and *org,* a generic top-level domain name signifying the truncation of organization. Offline, the term 'domain' refers to an area of a territory that is owned or controlled by a ruler or a government. A domain therefore, is a place where one has the power, or the right, to be at home.

The software infrastructure of DIYbio.org is a customized version of the theme

'React,' available from WordPress[19] at $61. The theme is one of many available via WordPress in its continuous effort to make the production of web content more accessible and interactive. As an illustration of such commitment, on the theme description page, under the section 'Introduce your brand', the process of filling up the theme 'React' is described: 'The home page introduces you and your work. First, drag and drop a featured image and it will show up at the top of the page.' In the case of DIYbio.org, a zoomed in image of a poster entitled 'diybio revolution' (see next section, figure 2.4) was dragged and dropped. The instruction followed: 'Next, add some text that introduces you or your business to your customers.' In the space provided, the co-founders of the DIYbio network have written a repeatedly-updated programmatic statement of intent. The most recent of these states that:

> DIYbio.org was founded in 2008 with the mission of establishing a vibrant, productive and safe community of DIY biologists. Central to our mission is the belief that biotechnology and greater public understanding about it has the potential to benefit everyone.'[20]

The statement is followed by a list of commented hyperlinks. Under the invitation to 'join the global discussion,' the first points to the listserv Google Group™. The second enables you to Find local groups and points to a list of up-to-date community laboratories supplemented with a Google Map showing the global distribution of biohackers. Other hyperlinks point to the initiative 'Ask a biosafety expert'[21], and two dormant initiatives, the 'quarterly postcard update'[22] and the 'DIY lab hardware'[23]. The last link directs the user to a page with an email contact and links from which to download the logos of the DIYbio network. The last bit of the instructions on how to fill the website theme concludes: 'It's also important for potential clients to see your

19 WordPress started in 2003 as a Free and Open Source personal publishing system, since it has turned into a sophisticated content management system 'limited only by your imagination.' Available at <https://wordpress.org/about/>. Last accessed 21 May 2014.

20 Available at <http://diybio.org/>. Last accessed 22 May 2014.

21 The 'Ask a biosafety expert' is an initiative that Jason Bobe established in collaboration and with the support of the Woodrow Wilson Center. The webpage enables users of the website to submit safety questions; these are then transmitted to a group of experts who post their answers on the same page. The initiative was inaugurated in January 2013, after the end of my fieldwork. Available at <http://www.synbioproject.org/news/project/6641/>. Last accessed 30 May 2013.

22 The 'Diybio postcards,' were a type of a 'micro-newsletter' established by Mackenzie Cowell. Members of the DIYbio network were invited to submit their project via Twitter, and had to subscribe to receive the postcard in their mail. After two 'volumes,' the initiative was discontinued. Available at <http://diybio.org/postcards/>. Last accessed 30 May 2013.

23 The 'DIY lab hardware' was a subsection of the DIYbio blog dedicated to hardware projects only. After four posts, the page went dormant. Available at <http://diybio.org/hardware/>. Last accessed 30 May 2013.

latest work and any news, and you can optionally include both of these sections in the footer of the page.' The DIYbio.org website makes use of this option. Each time a new post is uploaded onto the blog, a formatted summary is automatically published on the main page under 'Latest news,' therefore showing that 'the community' is producing new content. In this sense, blog posting, as a form of production, signifies that DIYbio members are active.

In proposing to discursively re-enact the gesture of filling of the website's theme with the content as it is currently visible on the central DIYbio.org web site, my purpose is to illustrate an authoring gesture guided by the instructions, but also, to illustrate what type of representations are produced. The instructions describe the filling in term of presenting either a brand and a company, or yourself. This juxtaposition suggests that, as a home, the website architecture can equally host both modes of identity making. DIYbio's co-founders are not seeking direct financial benefit from the establishment of the network, and neither are they branding a product in a strict sense. Yet, I argue, in a way similar they are using the website's theme to establish relationships and define a space of production where a certain identity can be defined and enacted via the making of web content. As part of this gesture, the programmatic statement defines the goals and the central beliefs of DIYbio's co-founders. Its authors give themselves the mission to establish a 'vibrant, productive and safe community of DIYbiologists,' a community organized around the belief that the combination of biotechnology and a greater public understanding of it might benefit everyone. While setting such goals, the programmatic statement makes use of new terms, the definition of which is one of the purposes of gathering new members through use of the Internet. The term 'DIYbiologist', and also 'biotechnology,' which, as DIYbio activities suggest, span from food fermentation to genetic engineering, discursively provide both a sense of direction and of open possibilities. Similarly, the aim of DIYbio is of 'establishing a vibrant, productive and safe community.' In this context, I read the use of the term 'community' in resonance with Bobe's professional role as a Director of Community. The term, and its synonyms of 'Community Director' and 'Community manager,' migrated from urban management to a multitude of curatorial practices of audiences and users via social media, customer support and event planning. In this sense, establishing a community is a curatorial process, an important part of which takes place online. Following the programmatic statement, an

online and interactive portrayal of 'the community' is given via an authored list of cascading hyperlinks. Hyperlinks facilitate the connection between content and the user without the need for specifying precisely what that relationship is, and as such they pursue the practice of defining by aggregating. A practice that was initiated by sending an e-mail as an invitation to people to gather to figure out what 'do-it-yourself biology'. By authoring the theme as guided by the instruction, DIYbio co-founders delimits porous but inspirational goals – goals of which the website is both an interactive site of production and a mode of address.

Online Identities: Making logos remixing politics

The establishment of Meetups® groups, mailing lists, blogs and websites as tools to organize without an organization, were almost immediately followed by discussions about the need for a DIYbio logo[24]. Already, in November 2008, a thread with eight authors and twelve messages discussed the issue on the DIYbio Google Group[25], the main mailing list of the DIYbio network. Towards the end of the discussion, one of the participants proposed the following logo:

Figure 2.4 Making logos.

The first logo of the DIYbio network: a leaf ready-taped to a neologism.

24 Recent ethnographic works have captured the moment of logo making and discussed in further detail the importance of such a moment in the formation of the identity of a DIYbio group (Choukah, forthcoming).

25 The discussion involving central DIYbio members is available at <https://groups.google.com/forum/#!searchin/diybio/DIYbio$20AND$20logo/diybio/i9tm6WPapOk/VSGl97pGgVAJ>. Last accessed 12 June 2014.

For a short time, this logo was used as part of DIYbio members recurrent PowerPoint presentations. But, in December 2009, Makenzie Cowell, DIYbio co-founder, announced in a post of the central blog that he had hired two graphic designers 'to design an extensible diybio logo and related illustrations.'[26] His post received two comments. The first and longest was from David Benque, a London based designer with an interest in synthetic biology. The designer felicitated the effort of giving DIYbio a visual identity, but argued that the wrong questions were being asked. He wrote: "it's not 'what 10 icons should be designed?' and trying to solve everything you will ever need in one set, but more how to create a truly DIY visual language." Similarly, the second user wrote:

> I think the visuals presented are waaay too busy. Not sure who said it first but, 'Brevity is the soul of wit.' What is the purpose of DIYbio? The mission. The vision. Sum it up in one sentence; if necessary, find a poet. Now, find an artist to draw a picture of it. People remember what is meaningful. People are moved by what is meaningful.

On the website of the designers hired by MacKenzie, under the portofolio of their projects, their work for the DIYbio network is described as follows:

> Mackenzie Cowell, the founder of DIYbio, asked us to create an identity system and illustrations that could be used by diybio.org and built upon by DIYbio's various regional groups. He wanted the final design to be extendable and support remixing by all interested parties.[27]

The 'identity system' was done in such a way that each regional group could use the same logo but in a different colours. After consultation, the system identity purchased by Mackenzie became the official logo of the DIYbio network and was made available under Creative Commons Attribution-ShareAlike 3.0 Unported License on the central DIYbio blog.

26 Available at <http://diybio.org/2009/12/11/diybio-graphics/>. Last accessed 12 June 2014.
27 Available at <http://www.hadilaksono.com/design#/diybio/>. Last accessed 13 January 2014.

Figure 2.5 The making of the DIYbio network: graphic identity.

From left to right, the logo of the DIYbio network (also available as a sticker), the 'diybio revolution' poster (often also used as logo), and the poster turned into a t-shirt.[28]

The logo of the DIYbio network is an emblem on which the neologism is located between two symbolic representations: on the top, a pair of a safety goggles, drawn as a hybrid between chemistry laboratory goggle and steam punk aviator goggle; on the bottom, an helix of DNA. While MacKenzie asked the designer to produce a graphic identity that could 'support remixing from all interested parties,' only two regional initiatives ended up adopting the logo. In contrast to this, the poster 'diybio revolution' became widely adopted by DIYbio members who used it at the beginning of their presentation when describing the network, on the poster of events they organized, or on the t-shirt they wore during public demonstrations. For this reason, I will take a moment to examine the iconography of the 'diybio revolution' poster. The image is occupied by a fist raised diagonally and holding a pipette. The thumb of the masculine hand is positioned on the 'push button,' ready for action. On the pipette's tip there is a drop of liquid and from it a swirling and macroscopic helix of DNA is released. As it reaches the hand of the biohacker, the double stranded helix

28 Available at <http://www.zazzle.co.uk/custom_diybio_t_shirt-235633781357933043>. Last accessed 13 January 2014.

'denaturates'[29], unwinding into two single strands. One strand of DNA unwinds as part of the background, forming what looks like sunbeams, while the other curls around the biohacker's wrist as a domesticated force, or a fashionable jewel.

A remix of the iconographic composition of the 'diybio revolution' poster can also be identified in the promotional material used for a number of recent initiatives directly related to the DIYbio network (Figure 2.6).

Figure 2.6 The 'diybio revolution:' remixes.

The resurgence of the 'revolutionary fist' as part of contemporary 'revolutionary' techno-scientific projects.

In the first image, the fist, this time vertically holding a microscope, occupied the poster of an event entitled 'The Revolution will be Bio-Based'[30]. An event co-organized by the Economic and Social Research Council (ESRC) Genomics Policy and Research Forum and the ESRC Innogen Centre, and held in 2012. I came across the image on the blog of a regional DIYbio group based in Manchester. Accompanying the image, a short text reported that 'the event consisted of a number of talks and workshops. These included discussions about how DIYbio can ignite young people's interest in the life

29 Denaturation is the technical name given to the unwinding of the DNA double helix when exposed at to temperatures between 94-96 ºC. Denaturation is one step of the Poly Chain Reaction (PCR).

30 The phrase is itself a post-modern maelstrom of hyperlinks. Originally 'The revolution will not be televised' was a poem and a song from Gil Scott-Heron. The original is a powerful statement against mainstream media and its role in the systematic concealment of black social movements. In 2002, the same title was used for a documentary on Hugo Chavez that coincidentally took place during the 2002 putsch. Finally, in 2012 the same phrase, but used as the positive statement 'The revolution will be televised,' became the title of a satirical TV show broadcast by the BBC.

sciences and how developments in biotechnology could benefit the UK economy.'[31] The second image is from the cover of an issue of The Scientist dedicated to the 'The rebirth of DIYBio' and published in March 2013.[32] The image is against a beaming red background announcing 'THE DO-IT-YOURSELF REVOLUTION.' Three arms, their sleeves rolled up, respectively hold in their fists a test tube, a wrench and an object which is difficult to discern. The editorial, entitled 'The Rebirth of DIYbio,' embraces the participatory promise of an emerging citizen science movement, swinging between its newness and its historical precedents, such as George Mendel or Mary Anning. As for the majority of other media outlets, DIYbio is described as challenging the dogma of an increasingly expensive and inaccessible 'mainstream science.' In the context, 'DIYbio,' as an umbrella term, is used in conjunction with articles about patients' experimentations (Akst, 2013), and other articles describing how to maintain and repair laboratory equipment given the reduction of NIH budgets after the 2008 financial crisis (Perkel, 2013).

In the first example, the fist holding the microscope is used to promote an event supported by a major UK research agency, and DIYbio is a means to conflate youth interest in biotechnology with a struggling national economy. Similarly, although using a more moderate tone, The Scientist issue nonetheless embraces the revolutionary promise of a 'citizen science' portrayed as a movement 'all in support of rigorous scientific research.' However, for a reader with my educational background, the fist, the pipette and the title 'diybio revolution' function as yet another mode of address. The iconography recalls another logo, that of Science for the People[33] (Figure 2.7).

31 Available at <http://madlab.org.uk/content/tag/diybio/>. Last accessed 12 January 2014.

32 Available at <http://www.the-scientist.com/?articles.view/articleNo/34457/title/The-Rebirth-of DIYbio/>. Last accessed 12 January 2014.

33 The group formed in the late 1960s, using direct action, publications and events to call attention to their cause and persuade scientists to dissociated themselves with the military, racism and sexism of institutional research. For an introduction to this topic, see the work of Kelly Moore (2008) and Matt Wisnioski (2003).

Figure 2.7 Iconography of the radical science movement.

Two versions of the logo from Science For the People as portrayed in a recent article about the movement published in the Guardian (Bell, 2013).

In it, a hand holding an Erlenmeyer flask in the foreground joins a leftist revolutionary fist. The first stands behind a recipient commonly used for laboratory experiments. For the members of Science for the People, this juxtaposition symbolizes another commitment, aimed at demonstrating that science and technology are not forces exterior to social struggles but that, on the contrary, they lie at its very core. These were activities aimed at challenging the relations and responsibilities of technoscience in the deployment and maintenance of capitalist oppressive regimes, but they also aimed at developing practices that avoided the perpetuation of oppression through technoscience (Péssis, 2014). Though the iconographic resemblance is striking, I argue that the two iconographic practices are underpinned by radically distinct understandings of the role of technology in social change. On the one hand stands the iconography of Science for the People, for which 'revolutionary' techno-scientific practices are critical of the relationship between technoscience and capitalism, and where individuals are invited to contribute to such critique. On the other hand, among DIYbio members, the term 'revolution' is intended as the development of hands-on and small scale technologies aimed at creatively transgressing the frontier of empirical and theoretical knowledge at the productive, rather than conflictual margins of contemporary scientific institutions.

In a post-financial-crisis world, shaken by fiercely real social struggles, I read these latest iconographic and political remixes as the expression of a renewed revolutionary discourse in technoscience: a contemporary version that after 'Renaissance,' 'Scientific

Revolution' and 'New World Order' is yet again a 'unique, transformative theatre of origin' (Haraway, 1997:179). On the bright stage of the theatre stands the supposedly empowered individual who, thanks to the rediscovered collectivities as enabled by online communication, can now join the revolutionary practice of technoscience. In the shadowy wings lurk the fiercely real social struggles.

In this section I briefly retraced the elaboration of the DIYbio logo as another site of identity making. I argued that, like the website, the logo was among the very early products of the group. The making of the logo relied on online discussions involving early members as well as sympathetic designers, but it also relied on the work of professional designers hired by the DIYbio co-founders. Similarly, as the neologism DIYbio, and the programmatic statement both work by setting a direction and addressing people upon whom their definition is based, I read MacKenzie's requirement of a 'identity system' that can 'support remix' as enabling a similar work.
Despite MacKenzie curatorial desire to produce an inclusive graphical identity, aimed at productively aggregating similar but distinct initiatives, the majority of regional groups eventually adopted the neologism, 'DIYbio,' but designed their own logos and regional group's names. However, the poster 'diybio revolution' was frequently used. Given its importance, I paused on its iconography. My brief analysis literally follows the poster's iconography in the way that it addresses me. By 'iconographic analogy,' the poster sends me back to two distinct but related sets of images. The first is the original DIYbio poster 'diybio revolution' and two recent remixes; the second are two logos of Science for the People. I argue that historically an iconography symbolizing political dissent, the one representing the commitment of Science for the People members has been remixed into an iconography symbolizing a participatory scientific transgression in the name of 'the people.' As part of this revolutionary project, social change is not expected to come from a deeper understanding of, and/or an opposition to, how science and technology contribute to capitalist oppression. Instead, social change is to be supposedly achieved by inviting everyone to join in the participatory and revolutionary making of a creative and personal biology for the people. At stake in these similar iconographies are two distinct theories of power. One one side, Science for the People's members propose that relations of power characteristic of technoscience are weakened by being relentlessly exposed to the public and made intelligible for everyone. Their hope is to contribute to the making of informed

decisions regarding the relations we have, with the products and practices of technoscience. On the other side, DIYbio and its followers propose that by establishing distributed organization enabling 'everyone' to practice technoscience, that will somehow lead to the re-distribution of power.

Continuing my analysis of the making of the DIYbio network, and in part moving away from the role of the co-founders and the central website, in the next section I focus on how DIYbio's early members used blogs as a relational technology. They used blogs as places where, I argue, they learnt the oratorical and textual skills of self-representation, collectively elaborated their identities, and immortalized and disseminated their socio-technical vision in-the-making. To do so, I begin by describing the authoring structure, the type of contribution it enabled and the type of content posted on the selected blogs, and I conclude by analysing the blog posts describing experiments and/or laboratory practices.

Third snapshot – Blogging as the collective figuring out of a user friendly biology

Group authored blogs, where only a few authors post most, if not all, the content are the most common type of blog; this is the case for the central blog diybio.org/blog and the blogs of other regional groups. A minority of DIYbio bloggers use an easily identifiable user name, while the majority sign their post with their civic names. Their identities are disclosed and, hence, so are the means of contacting them as individuals or as a group. For instance, on the blog of La Paillasse, the regional group based in Paris, Thomas Landrain, who is a Ph.D. student in synthetic biology and the group's major advocate, is also the most regular blogger. If the majority of blogs are group authored, their content is mostly produced by influential members, thus reflecting dominant voices within the network. Nonetheless, these voices are not necessarily those of members with an educational and/or professional background in the natural sciences. The example of Daniel Grushkin is relevant. In 2009, Grushkin, a trained freelance journalist, attended the iGEM at MIT to report about the international student competition (Grushkin, 2010). On campus, he came across the first off-line international meeting organized by DIYbio members, and ended up becoming a founding member of New York regional group, lately called Genspace. The first hands-on experiment took place in his flat. When I asked him about his contributions to the group, Grushkin explained that he had been involved in all the decision making

processes, but he also added that as he does not have a 'technical background' his day-to-day role is taking care of lot of communication: talking to journalists, putting together PowerPoint presentations and blogs posts, and generally ensuring that the 'group has a clear message.' Despite this being his main role, he also stressed that decision making on editorial practices is a collective process. Although Grushkin has also been involved in some hands-on projects, the authoring of posts is for him an important way to contribute to the group.[34] Thus, as a publishing practice, blogging is open to anyone who has writing skills and an interest in DIYbio. As such, it provides an opportunity for individuals without a technical background to contribute to the making of DIYbio. Blogging is also open to individuals who are not per se members of the network. These include scholars who are studying the DIYbio network or collaborating with its members. Among the guest bloggers is, for instance, Todd Kuiken, the co-ordinator of the collaboration between the DIYbio network and the Woodrow Wilson Center, a science policy making thing tank (see Chapter Six). But Guest bloggers also include other academics who collaborate with regional groups. For instance, Joel Winston, who did his field work on the DIYbio regional group in London as part of his Master's degree in science communication (Winston, 2012a), temporarily became the main author on the group's blog. Since then, the blog has been mostly dormant.[35] Lastly, Bobe and MacKenzie's recent invitation to Cat Fergurson, a science and technology journalist, to 'dust off' the dormant diybio.org/blog/, reflects the co-founders' desire to maintain an active central blog, even if it implies to requires calling on external actors.

Before moving to the my analysis of the content posted on the blogs, I want to comment on the fact that this first section presented the blogs' authors as a specific multiplicity. One composed of highly educated authors in fields such as synthetic biology and the life sciences, but also, for instance, writers working in journalism or, science communication, and or scholars. This is a multiplicity that does not regenerate

34 Grushkin is not the only professional journalist who is a member of the DIYbio network. Rachel Turner, a founding member of DIYBIOMCR, the regional group based in Manchester, is also a professional journalist. Grushkin and Turner do not only help DIYbio members to have a clearer online message, they also advise them off line on how to administer their relationship with the mainstream media. An example is their involvement in the organization of a workshop entitled 'How to speak with the journalists,' held in 2012.

35 Available at <http://biohackspace.org/news/>. Last accessed 12 July 2014. Winston not only became an advocate of DIYbio by blogging for the regional DIYbio group in London, but also, as a professional science communicator, he wrote twice about DIYbio in Wired UK Online (Winston 2012b and 2012c).

with a monopoly of speech from trained scientists, neither does it indiscriminately include the promised 'everyone.' To With the exception of one personal blog, where the author writes about national and international politics concerning issues such as surveillance, and digital rights, the groups' authored blogs are only dedicated to DIYbio, and DIYbio related themes. It is only the subject of the blogs that goes any way towards revealing the identity of the blog's author, and that become relevant to the exchange between individuals who presents similar online identities. This is a specific practice of showing particular parts of one's self-identity that Michel Gensollen has called 'instrumental intimacy' (Gensollen, 2004). Moreover, while a specific multiplicity of authors circulates on DIYbio blogs, DIYbio members also circulate within a variety of related blogs. These include the blogs of craft magazines,[36] the mainstream press,[37] and science organizations such as Euroscientist, the British Science Association,[38] and SpotOn, a blog from Nature Publishing Group dedicated to the discussion of 'how science is carried out and communicated online '.[39]

The circulation of authors within the DIYbio network and of DIYbio members as authors among other social media outlets, is to be considered in conjunction with another type of circulation, that of the blogs' content itself. With the advent of social media, the participatory practice of commenting on blog posts, has been supplemented by the practices of disseminating web content: the reader is therefore not only invited to leave comments, but especially, by using social media such as Twitter, Facebook, Pinterest or Reddit, she or he can also disseminate selected posts on her or his own social network. These common features are also used as part of DIYbio's blogs. For instance, on the blog of Genspace, the regional group based in New York, the common sharing banner is customized:

Figure 2.8 Share the science.

A snapshot of the customized sharing banner from Genspace's blog.

36 Available at <http://makezine.com/author/erigentry/>. Last accessed 27 February 2013.
37 Available at <http://www.theguardian.com/uk/the-northerner/2012/jun/18/manchestermetropolitanuniversity-biology-diybio-madlab-fbi-california-conference>. Last accessed 26 February 2013.
38 Available at <http://www.britishscienceassociation.org/people-science-magazine/december-2012/biohackers-rise ex_164 >. Last accessed 28 February 2013.
39 Available at <http://www.nature.com/spoton/2012/12/spoton-nyc-diy-science-diybio-europe-kick-off/>. Last accessed 28 February 2013.

Within the blog considered in this section, only few posts are commented upon, while a larger proportion is circulated via Tweeter and other social networks. Additionally, the powerful trope of sharing as re-enacted by digital technologies is combined with the reformed ideal of a science to be shared by all and with all; now possible by using social media. As a consequence, each of the blog's readers become potentially an additional points of circulation of the content published on DIYbio's blogs, and therefore an active mediator of DIYbio socio-technical vision. In the next section I look at the types of content produced by DIYbio members on their blogs.

Reporting from a community in the making

Before moving to the analysis of the posts I am most interested in, the one which are those where DIYbio members document their practices, I would like to give a brief overview of the other major type of posts. These are: highlights from the network, reports of the appearance of DIYbio in the mainstream media, and reports from the participation of DIYbio members in events put on by third party organizations. The posts which are highlights from the network are unique to the central blog, while the other types of post are common to the central and regional blogs.

Posts reviewing the state of DIYbio in the form of highlights of the network, are explicitly described as an effort to make the overwhelming number of messages exchanged on the DIYbio Google Group™ intelligible to newcomers, thus making the central blog the inviting and intelligible forefront of the messier and potentially alienating collection of conversations exchanged on the discussion group. This curatorial work, carried out by the most frequent bloggers on diybio.org, illustrates a recursive and self-reflexive communication practice. A practice that is not only aimed at members of the DIYbio community, but mostly at reaching out for new members. Also, in making the content of the discussion group more intelligible, authors, also familiarize themselves with the ongoing discussions, and thus develop a more detailed representation of what is, or might be, DIYbio.

An important number of posts on the central and regional blogs celebrate the appearances of DIYbio in the mainstream media, and the generally enthusiastic reaction of the mainstream media[40] or scientific journals[41]. More rarely, the posts invite

40 For instance, an article celebrating DIYbio appeared in Wired Magazine. Available at: <http://diybio.org/2010/08/> Last accessed 25 February 2013.

41 For instance, an article celebrating la Paillasse was published in Nature. Available at: http://lapaillasse.org/magazine-nature-la-paillasse-is-the-continents-largest/>. Last accessed 25

the readers to engage with some of the concerns raised by the journalists.[42] By being blogged about, the appearance of DIYbio members and projects in the mainstream media become a shared evidence that DIYbio is a subject of interest. Such credibility, is not only celebrated among the members, and archived together with other types of recognitions such a science fairs' awards, but also becomes another public illustration of the success of DIYbio available to newcomers. While a self-reflexive curatorial practice is illustrated by the previously discussed type of post, this second type of post illustrates that DIYbio members actively monitor their image in the mainstream media.

The last type of frequent post are those reporting on the participation of DIYbio members at events that are put on by third party organizations. These mostly consist of conferences where DIYbio members tell inspirational stories about what DIYbio is, and events where they propose participatory public demonstrations to the attendees. Recurring conferences that DIYbio members have been reporting about on their blogs include: O'Reilly Ignite®[43] and O'Reilly® FooCamps[44], transhumanist events organized by the H+ network[45] (especially in California and Boston), and more recently Technology, Entertainment and Design (TED) conferences[46]. Recurring events where DIYbio members showcase hands-on activities which are then reported on their blogs include O'Reilly® Maker Faires and a variety of regional science festivals, sci|art events and Hackatons[47] (see next chapter). Public presentations, especially when

February 2013.

42 For instance, see: <http://diybio.org/2009/12/20/do-it-yourself-biology-on-the-rise-sf-chronicle/> in respect of biosafety issues. Last accessed 27 February 2013.

43 Started in 2006, on its website Ignite is described as: 'Ignite is a fast-paced geek event started by Brady Forrest, Technology Evangelist for O'Reilly Media, and Bre Pettis of Makerbot.com, formerly of MAKE Magazine. Speakers are given 20 slides, each shown for 15 seconds, giving each speaker 5 minutes of fame.' Available at: <http://igniteshow.com/howto>. Last accessed 27 February 2013.

44 FooCamp is an un-conference gathering 'people who are doing interesting works in the new creative economy, mobile, big data, hardware hacking, open government, gaming, open source programming, computer security, geolocation, cognition, and all manner of emerging technologies to share their works-in-progress.' Available at <http://foocamp12.wiki.oreilly.com/wiki/index.php/Main_Page>. Last accessed 11 July 2014. For a similar type of event see also Hackathons, described in footnote 51.

45 Available at <http://diybio.org/2009/12/10/bryan-bishop-reports-from-hplus-summit-2009/>. Last accessed 27 February 2013.

46 More sporadically, DIYbio members also participated in computer hacker's conferences such as Codecon in 2009.

47 'Hackathons,' a combination of 'hacker' and 'marathons,' is a term for one of the many events where technology enthusiasts gather to work collectively and, intensively on a particular topic over several hours or days (Coleman, 2010). Inspired by the famous Homebrew Computer Club, and organized non-hierarchically. Hackathons enact a variety of technological and political commitments by addressing 'problems' via software coding (Haywood, 2013). From solving humanitarian problems to improving urban planning or government transparency, the organization of such events are often sponsored, or directly organized by large corporations as fast-paced innovation incubators or head-

organized by influential organizations such as O'Reilly and TED, are important occasions for DIYbio to exercise their skills at story-telling, or to elaborate persuasive public demonstrations. In the case of Ignite and TED, these are also occasions to piggyback the media service offered by these conferences. Both Ignite and TED offer video recording and editing services; once ready, the videos then become a type of web content that is directly used in the posts on regional blogs. More importantly, by sharing with the readers the difficulties that one has to overcome in giving a presentation,[48] the pride of being invited,[49] or the satisfaction of being awarded a price,[50] the DIYbio members describe and share a spectrum of achievement that has come to define what it means for DIYbio members to be successful. But if these are important types of posts, the earliest and most frequent type of posts is report from the activities organized by DIYbio members. For this section, my purpose in briefly describing several examples of these is not to determine whether biology and biotechnology, as a practice, can or cannot be portrayed online using accurate descriptions and accessible terminologies, or to determine the actual effort that that would require. My interest instead lies in understanding how DIYbio practices are portrayed on their the blogs, what sort of language is used, and more generally how biology and biotechnology become yet another type of web-content on social media.

Documenting DIYbio meetings and public demonstrations

On the central blog, the very first post reported the early meetings of regional groups which were located, in order of their establishment, in Boston, San Francisco and Seattle. These meetings were described as crowded and 'a huge success!' The blog also mentioned that the meetings received attention from local science bloggers.[51] The authors of the central blog celebrated the promise of a DIYbio getting 'off the ground,' and the 'era' of DIYbio that, they said, is 'upon us.'[52] Others authors, like the one

hunting sites (Meyer and Ermoshina, 2013).

48 Available at <http://www.indiebiotech.com/?p=25>. Last accessed 27 February 2013. Videos of presentations were uploaded onto Youtube in October 2011, the video had 872 viewers on 12 June 2014. The same video was also uploaded onto the Ignite website.

49 Available at <http://lapaillasse.org/la-paillasse-a-tedxparisuniversite/>. Last accessed 27 February 2013.

50 Available at <http://lapaillasse.org/diy-bio-based-electronics-prime-a-la-maker-faire-rome/>. Last accessed 15 March 2014.

51 Available at < http://diybio.org/2009/01/04/first-seattle-diybio-meetup/>. Last accessed 28 February 2013.

52 Available at < http://diybio.org/2008/10/11/diybio-meetup-in-boston-on-thursday-october-16/>. Last accessed 22 February 2013.

reporting from the first meeting in San Francisco, were written in a more intimate prose. The post described ideas as being 'tossed around'[53], and was illustrated with a picture taken by Tito Jankowski, a graduate in biomedical engineering and the convener of the meeting (Fig. 2.9). Those responsible for answering the e-mails were sitting around the table of a fashionable restaurant chain that specialized in Belgium street food. They were: John Cumbers, a computer scientist with a Ph.D. in Cellular Biology working for the synthetic biology program at NASA Ames Research Center[54] and the Biotechnology and Bioinformatics track at the Singularity University; Spencer, a graduate student; and Marnia Johnson, a sculptor and 'interdisciplinary investigator'[55].

Figure 2.9 First gatherings.

DIYbiologists John, Spencer, and Marnia enjoy Frjtz fries

The ones who gathered at the first meeting of DIYbio regional group in San Francisco.

For these first regional groups, the central blog offered a space where their activities could be reported before the opening of dedicated blogs. Regional groups that formed later begun reporting by directly opening their own blog or, sometimes, several blogs. For instance, the first post of La Paillasse, the regional group in Paris, welcomed its readers onto a blog originally named 'biopower,' and announced that there were up-coming articles about 'house-made biology' (biologie 'fait maison'). A term, the one of

53 Available at < http://diybio.org/2009/01/19/bay-area-diybio-meetup-1/>. Last accessed 12 March 2013.
54 Available at < http://openwetware.org/wiki/User:Johncumbers>. Last accessed 26 February 2013.
55 Available at < http://marniajohnston.com/contact.html>. Last accessed 12 March 2013.

biopower that, for a number the readers of this text, might mean something quite different from a house-made biology.[56]

Figure 2.10 The first post on the blog of La Paillasse.

These early posts were followed by others reporting the first public demonstrations; in the case of Boston and San Francisco, respectively, demonstrations were given of gel-electrophoresis[57] and 'Glow in the dark cells.'[58] These posts are written from the first-person or first-person-plural narrative. As a reader, one is addressed as the 'you' who could do the experiment, or implicitly included as member of an extended 'we.' The author of the post from San Francisco began with: 'The pressure cooker shot out steam, like an enormous teapot. At over 200˚F, steam had just sterilized our liquid agar, the favourite food of growing cells.' The reader has the impression of having the activity described to her or him, and being guided through it. The narrative style is entertaining and colloquial, and the simplicity of the descriptions have a persuasive strength: one aimed at demonstrating that doing biology is easy. Authors describe which kit and ready-made tools are used,[59] where the activity took place, and who attended it. Kits, tools and places are not simply described. Key words or iconic

56 I will come back to this issue in chapter seven 'On being a good biocitizen.'

57 Gel-electrophoresis is a laboratory technique used to identify fragments of DNA, RNA and protein by charge. In the case of DNA, samples are 'loaded' on an agarose matrix, an electric field is applied and the molecules migrate and separate according to their size. For more on these practices, see the next chapter 'The making of a personal biology.'

58 This activity was carried out using the 'Green Gene Colony Transformation Kit' sold by Carolina Sciences, a major supplier of science and maths educational material. The kit enables the genetic modification of bacterial cells so that they would express a fluorescent protein, thus 'glowing in the dark.' Available at <http://diybio.org/2009/04/02/diybio-san-francisco-glow-in-the-dark-1/>. Last accessed 15 March 2013.

59 Numerous early and ongoing activities made use of purchased educational kits or followed the instruction of activities developed as part of educational initiatives. In this case, the instructions to perform the gel-electrophoresis were taken from Make Magazine and the 'glowing bacteria' were produced by purchasing a kit from Carolina. For the relation between science education and a DIYbio practices see the next chapter.

expressions are hyperlinked to external webpages where the reader can find further instructions or purchase the kit. Images and videos complement these posts. The descriptions and the pictures, often posted in sequential order, recapitulate the different steps of the activity.[60] This narrative style is consistent throughout the blogs used in this analysis. For instance, shortly after the fourth meeting of the New York regional group, in April 2009, a post entitled 'Creating Glowing Green Bacteria for Earth Week' was posted on their blog.[61] The regional group's blog post reported about the genetic modification of bacteria with green fluorescent protein using a purchased educational kit. Again, the writing style is informal:

> The day before Earth Day[62], we gathered at Dan's [Daniel Grushkin] apartment in lovely Park Slope to do our first biotechnology experiment. We used a kit developed for high school students. Basically, E. coli K12 is so safe that you could drink it with no ill effects (although it would taste horrible). We decided to wear gloves anyway, although they were not necessary.

In the post, the major steps of the protocol were briefly described and the blogger concluded by inviting readers to watch the video of the first half of the evening that was embedded in the post.

For this post, few hyperlinks were used and the post was illustrated with a picture (located before the description). The picture, which is a snapshot taken from the video (see Figure 2.11) is annotated with arrows and texts. Arrows point at the experimental devices; more specifically, they point at biosafety devices such as the gloves worn by 'both bench workers,' the plastic mat on the table, the paper towel to wipe up spills, and the closed doors. But an arrow also points at an additional element of the biosafety setting: a 'NY Times reporter to keep us honest.'

60 Available at < http://diybio.org/2008/07/14/diybio-3-gel-electrophoresis/> and <http://diybio.org/2009/04/02/diybio-san-francisco-glow-in-the-dark-1/>. Last accessed 15 March 2013.

61 The post is not available on the current blog of the group, but is available on the first blog that they opened. Available at <http://biohacknyc.blogspot.co.uk/2009/04/creating-glowing-green-bacteria-for.html>. Last accessed 15 March 2013.

62 First celebrated in 1970, Earth Day is an environmentalist celebration and awareness day, for a description and critique see David Lowenthal (1970).

Figure 2.11 In Dan's living room.

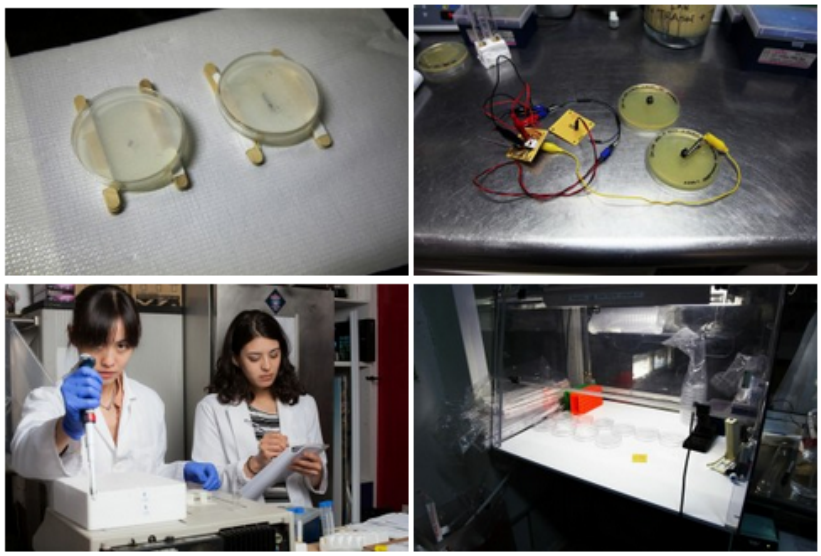
Documenting biosafety, and documenting the ones who document.

The image shows five individuals in front of a table covered with what looks like a thin blue plastic tablecloth on which instruments and the materials required for the demonstration are laid out. The image is a snapshot from a video comprised of two parts, each of approximately ten minutes, and embedded on the blog and hosted on Youtube as part of the DIYbioNYC's Youtube Channel[63]. As for other regional blogs, posts published on the Genspace's blog became more curated. For instance, the post 'Member Project: Vivian Xu's Living Devices,'[64] published in June 2013, reported about a project created by Vivian Xu, a chinese bio-artist, which aimed at making bacteria grow following fields of electrical currents. The post was illustrated with numerous large and carefully taken pictures which were uploaded individually, or in a series, to illustrate different steps of the project (Figure 2.12); the post also included a seven minute video of Xu's graduation presentation.

63 The account has been dormant since 2010. Available at <https://www.youtube.com/user/DIYbioNYC>. Last accessed 15 March 2014.

64 Available at <http://www.genspace.org/blog/2013/06/03/member-project-vivian-xus-living-devices/>. Last accessed 15 March 2014.

Figure 2.12 Illustrating experiments.



Four juxtaposed pictures chosen to illustrate the different steps of Xu's experiment.

The blogger explained that

> In the tradition of scientists and DIYers alike, Vivian provided extensive documentation, giving her project real methodological and theoretical rigor. Can't wait to see where she takes her art/science next.

I repeatedly tried to access the hyperlink, but each time it re-directed my browser to an error page. Broken links are only an ironic entrance to the question of how DIYbio hands-on activities are documented online, made public and therefore contribute to the socio-technical vision of a biology and a biotechnology accessible to all. To illustrate this question, I chose a last example that I found throughout my blog analysis to be one of the most detailed posts produced by DIYbio members.

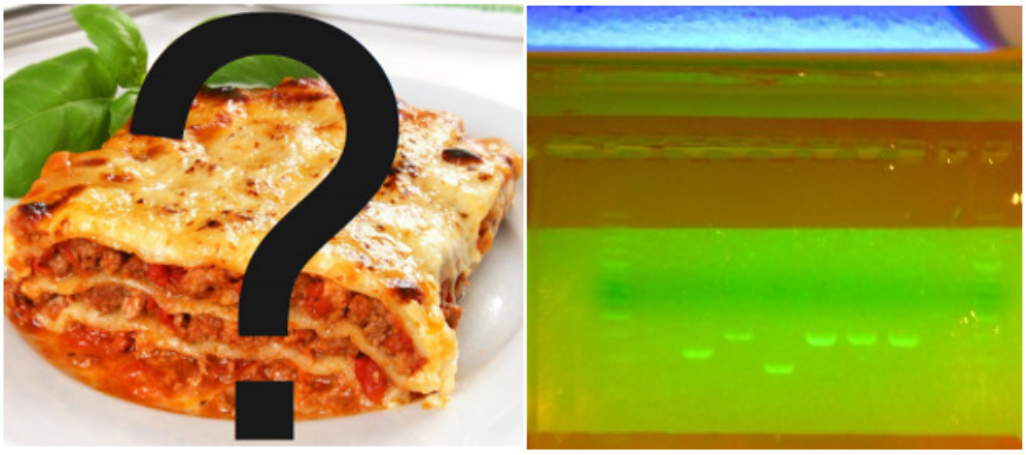
On the blog of La Paillasse, the regional DIYbio group located in Paris, Thomas Landrain, a co-founder of the group and the major author of the blog, posted what he named the 'quick and dirty' version of DNA barcoding.[65] The posts opens with a phrase announcing: 'Voici la méthode la plus simple, la plus rapide et la moins cher pour analyser ce que vous avez dans votre assiette !'[66] Simplicity, rapidity and inexpensiveness are the qualities of the analysis proposing to look at what is in readers'

65 DNA barcoding is a technique enabling the identification of species using their DNA. The term and the technique were proposed in the early years of this century by biologist Paul Hebert and colleagues (2003).

66 Available at <http://lapaillasse.org/la-version-quick-and-dirty-du-dna-barcoding/#more-1063>. Last accessed 15 March 2014.

plates. The post continued by explaining that barcoding is a technique commonly used in biology to determine the species of a living organism, but that it can also be used to determine whether a food has been produced using Genetically Modified organisms, or contains types of meat that are not indicated as ingredients. The blogger continued by explaining that while DNA barcoding is one of the regular activities proposed at La Paillasse, due to the recent meat scandals 'nous proposons des ateliers spécifiquement pour que vous puisiez apprendre à déterminer de quoi sont faites vos lasagne ;).' The blogger concluded this sentence with a winking smiley, suggesting a complicity with the reader's consideration of the possibility that his lasagne contained horse meat. The author continued by proposing that: 'En sacrifiant de la sensibilité à la méthode, nous avons réussi à réduire le temps d'analyse à 4h (au lieu de 3j!) et à un cout que d'environ 3-5 euros (au lieu de 200 euros) par échantillon!' This post was illustrated with two pictures.

Figure 2.13 Industrial lasagne :the question and the answer.



On one side, a dish of appetizing lasagne marked with a worrying question mark. On the other side, the supposedly explicit answer as glowing out of an electrophoresis gel produced during one of the barcoding experiments carried out at La Paillasse.

The post received three comments. The first of which was from a user interested in joining one of the barcoding workshops. The second of which was from a user who complained about the use of the English in the title and the third was from a professional journalist who was interested in getting in contact with the group to do a report about the workshop. In this example, hyperlinks directed the reader's attention

to the 'full documentation:' two downloadable documents of the protocol, and the Wiki of La Paillase. The blogger invited the readers to read and comment on the protocols. The first document was the 'complete protocol,' a three thousand word description of the DNA genotyping. The second document, that, as the blogger explained, inspired the cheap and dirty version of La Paillasse, was the scientific paper published by researchers from the Japan Meet Processors Association and the National Institute of Animal Industry in *Meat Science.*

The introduction of the complete protocol is the same as the text published in the blog post. The first four sections explain the major steps of the protocol in an informal tone. In the same way as is the case in the blog post, the reader is directly addressed as the common 'you.' When presenting the techniques involved, such as the PCR, the protocol refers to the original paper gives the reader Youtube links or other online resources where he or she can learn by watching and reading. These introductory explanation are followed by the detailed protocol. Hence, the language changes. Technical terms are used and the reader is no longer addressed directly, the impersonal language of scientific writing is used instead. Once the protocol presents how to read the results, the personal tone comes back. Other than the picture of the gel (which is not commented upon), there is no record in the blog, in pictures or writing, of the results obtained by, or the difficulties encountered in, the experiment.

In this experiment, a cheap and quick hands-on version of a technique usually used in food laboratories, becomes a demonstration of how science, when put in the hands of people (in this case via medium such as blogs), can enable individuals, including blog readers, to know the truth about what is on their plates. The convergence of post-financial crisis cuts in government-run food testing laboratories (Lawrence, 2013a), and with the breach in accountability of food supply chains under neoliberal economies and their collision with organized crime (Lawrence, 2013b), are overshadowed here by a joyful and empowering demonstration of a cheap and dirty genotyping workshop. The political complexities of the crisis of institutionalized accountability in neoliberal democracies are not an easy topic to blog about, nor is it easy to propose an brief, inexpensive and interactive hands-on activity that seeks to restore, at least in principle, the participants' sense of individual agency.

Instead, the activity of La Paillasse easily suits the narrative requirements of a blog post. Additionally, by inviting everyone to analyse the DNA in the industrial lasagne,

the activity gives the participants the deceptive impression of becoming able to individually address such crises. Inviting the reader to join and try for themselves the experience at La Paillasse, Thomas Landrain sign the post 'DNAment vôtre.'

As with the vast majority of the posts analysed in this section, this one simply ends by inviting the readers to join the ongoing experiments in the respective community laboratory. Of the posts on DIYbio blogs, few actually describe the outcome of the public demonstrations. In those cases where the outcome of a public demonstration is described, if it was successful then the activity is celebrated as a proof that an amateur biology is possible. If it was unsuccessful, it is the learning experience that is highlighted. For instance, in a post on the Manchester regional group's blog, Asa Calow the co-founder, concludes:

> Regardless of results, it's been a learning process for all involved and we are very proud of our PCR machine and all the buzz around it. Seems like amateurs are gaining more and more knowledge in different spheres of science and we love to be part of that development. Stay tuned for a PCR rematch, as well as some more DIYbio experiments in the future!

I understand the examples presented in this final section as a specific practice of scientific documentation as mediated by blogs. By publishing short, compelling descriptions, supplemented with sequential images, videos and hyperlinks, DIYbio members' aim is to publicly demonstrate that not only is biology and biotechnology just another subject one can blog about, but also that blogs can become a media for sharing knowledge and practices about biology and biotechnology. Similarly, by being mediated by blogs, intended as an intermediary form of expression between auto-publication tools and form of collective communication, DIYbio documentation becomes a relational technology that, as Anke te Heesen argued, is similar to the notebook (2005). But also, I argued, the capacity for a blog to gather people together is a realization of Internet's ideal of connecting everyone. The reader is virtually already part of the experiment and therefore of the group. Furthermore, by being supplemented with videos, images and hyperlinks, readers have the partial impression of establishing their own path of interpretation by choosing their own route among the content at their disposition. It is partial, in the sense that such a path is defined within the authored multi-dimensional material provided by the bloggers.

Reading these blogs is as much about acquiring certain information about what

DIYBio members are doing, as it is about witnessing a digitally mediated public demonstration. Throughout the chapter, I have used the term 'public demonstration' in reference to the work of Simon Schaffer (2005). Writing about public experiments in early seventeen-century, Schaffer proposes that essayist did not only compete to provide the most convincing solution to a mathematical, physical or astronomical problem, but that at the same time performed solutions to problems of political order (Schaffer, 2005). I view the blog-mediated documentations of public demonstrations in the life sciences not as aimed at convincing readers about a new solution to a biological problem; rather, the reader becomes the witness in an experiment aimed at demonstrating that everyone can do biology. The problems of political order addressed in DIYbio case are those of a biology understood as to be confined into institutional spaces. The Internet, in this case through the medium of the blog, becomes one of the 'non-institutional spaces' where the making of the DIYbio network, in term of user's identities and practices can exist in the public domain. The recursive myth of scientific universalism, according to which science is enterprise open to everyone, is here re-enacted through the use of personal communication technologies. Finally, by being portrayed on blogs, DIYbio practices not only acquire another level of visibility, they also become a permanent part of the Internet as an archive, and therefore constitute a significant part of the online collective memory of the DIYbio network. On the Internet, the transient practices of a DIYbio in-the-making therefore become immortalized.

As social media, and blogging in particular, become an important relational technology, blogging becomes a site where biology and biotechnology become a type of web content circulated via social media. Despite articles such as 'Biotechnology and the Internet,' (Lee *et al.*, 1998) offer fascinating accounts of the very beginning of the Internet and the first biotechnolgy websites, recent accounts of the phenomena of biotechnology's relationship to the Internet are mostly preoccupied with the strategic impact of Internet technologies in the sector of biotechnology, and therefore offer little critical insight. In other words, if a lot has been written about blogs, and a lot about biotechnology, the question of how the socio-technical vision of a biotechnology available to all is blogged about, seems to have remained unaddressed. For this reason, to conclude my analysis of DIYbio's blog I turn to the work of Cardon and Delaunay-Teterel (2006), and in particular to one type of blog that they analyse as part of their

typology: blogs maintained by 'pro-ams,' professional-amateurs. Cardon and Delaunay-Teterel locate the figure of the 'pro-ams' as part of their analysis of the effects that the increasing importance of cultural capital has on the organization of work and capitalism. 'Pro-ams,' they write, have a relatively high life standard, a broad and and diversified sociality, they have time for hobbies, and are familiar with new technologies. Their productions, combine practices taken from artistic disciplines. They are marked by the remix, détournement, and coupling which result in the composing of new objects which might have a higher notoriety than their originals. Most of them work in professional sectors with a high intellectual dimension, but often are in uncertain professional positions within these professional sectors. The blogs curated by 'pro-ams,' Cardon and Delaunay-Teterel conclude, are aimed at recruiting peers and at producing creative professional identities. With regards to the first snapshot, but even more after and especially the second and third one, it seems to me that Cardon and Delaunay-Teterel's analysis strongly resonates with the themes addressed in the chapter. A major difference is that 'pro-ams' blogs about writing, theatre, photography or craft but not about biology and biotechnology. Considered as 'pro-ams,' DIYbio members also use blogs to 'make themselves.' In their case, identity making as a relational technology, I argue, results in the production and dissemination of biology and biotechnology as a user-friendly technology.

Conclusion

This chapter opened with a quote describing the use of e-mails as a technology to gather like-minded people with the aim of figuring out what a do-it-yourself-biology might mean. The quote introduced my interest in how social media, understood as an extension of Haraway's metaphor of hypertext, is a technology of realization. In particular, my interest is in how, by using social media technologies, DIYbio members have been making themselves as much as they have been creating their public discourses and socio-technical vision of a personal biology.

In the first snapshot, following Bobe's tale of the origins of DIYbio as a neologism, I argued that the term DIYbio works as a proto-trope – a semiotic-material space to be inhabited where personal genomics can be reconfigured as a technology available to all and which first stable form is a dormant Internet domain. Similarly, I have argued that MacKenzie's username '100ideas,' and especially his use of a personal

blog to share streams of prototypes, is reminiscent of the notebook as a paper technology to collect people. MacKenzie's love of the idea that biology can be engineered fuels his motivation to figure out a way for biology to become like open-source programming – a movement composed of amateurs and hobbyists alike who collectively push the field further. In briefly presenting how the making of the DIYbio network was mediated by a person describing himself as a futurist and a technology catalyst, I made the point that a mediated relation, the relationship between Bobe and Cowell, was the first product of their figuring out process.

I then continued with the second snapshot, by discursively re-enacting the gesture of filling up the theme of the central website of the DIYBio network. My aim was to illustrate how the instructions were aimed equally at guiding the presentation of a company and guiding the description of a person. In these two aims of the instructions, I saw the ways in which the website, as a technology of realization, could mediate the combined production of the self and 'production' broadly intended as the activity specific to a company. The productive ambiguity of the instructions is particularly expressed by the programmatic statement. As for the neologism of Bobe and the prototypes of MacKenzie, I proposed that the online programmatic statement works both by establishing porous goals and by being a mode of address. Its aim is to gather the individuals who are expected to define the actual content of what is described in the statement, i.e what do-it-yourself biology actually is.

By further focusing on the making of the DIYbio logo, and in particular on the poster entitled 'DIYbio revolution,' my aim was to describe the logo as one of the very first products of the DIYbio network. Thus, I described how DIYbio moved on from using social media as a place where to produce definitions, to use social media as a place where to produce visual identities. By pausing on the iconography of the poster, I proposed that the image is a remix of a distinct traditions. In the oldest iconography, that of the logo of Science for the People, the fist stood in front of the Erlenmeyer, symbolizing the group's commitment to exposing and critiquing the role that science and technology play in maintaining capitalist regimes. In the example of the DIYbio poster, the fist firmly holds a pipette – or a microscope, and a test tube – thus, I argue, the image instead invite everyone to join in the participatory and revolutionary making of a creative and personal biology for the people. If the iconographic resemblance is striking, the two iconographic practices, I argue, are underpinned by radically distinct

understandings of the role of technology in social change.

In the third snapshot I proposed to look further at how DIYbio members have used blogs to portray their own activities. I argued that, as the identity of the bloggers as well as the means of contacting them are disclosed, blogs are used to recruit peers and disseminate a public discourse about a socio-technical vision in the making. For instance, by being open to anyone with writing skills and an interest in DIYbio, blog authorship allows members without a technical background to contribute to the making of the network. This includes scholars who establish collaborations with the members of the network. Blogging is also a way for the co-founders to make intelligible to the newcomers the overwhelming number of messages exchanged on the discussion list. By blogging about the attention received from the mainstream media, DIYbio members publicly celebrate the credibility that their socio-technical vision has acquired. In this sense, the blog enables members to share concerns and become self-reflexive – a self-reflexivity that is mostly preoccupied with the thriving of the network.

While these blog's posts are important to understand how blogs as a relational media participated in the making of the DIYbio network, the majority of posts actually report from events organized or attended by DIYbio's members. With respect to the first type of post, I have argued that these post are as much about reporting as about documenting and immortalizing the DIYbio events. In particular, they enable the reader to witness a digitally mediated public demonstration aimed at persuading them that biology is becoming a personal technology that everyone can interact with. Thus, I argue, the myth of science as a universal practice is enacted through the form of interactivity and participation enabled by social media technologies. The last section of the second snapshot proposed to further look at how DIYbio members have used blogs to describe their own activities. Following the typology of blogs as relational technologies proposed by Cardon and Delaunay-Teterel (2006), and in particular in relation to their figure of the 'pro-ams,' I concluded by arguing that DIYbio members are producing a user-friendly biology and biotechnology that can be blogged about and collectivelly produced at the productive margins of mainstream science institutions.

3. The making of a backyard biology

The counterculture is ageing fast and starting to die. The best counterculture now is in biology. As far as I can tell, biohackers are all adventurous young people, incredibly athletic, and they're all travelling the world. I don't know if biohackers are as much fun as the computer hackers were, but they're way more responsible. They monitor their own potential misbehaviour in a way that computer hackers never have.

Stewart Brand, in an interview for Wired Magazine, 17 August 2012.

Introduction

One of the key aims of this thesis is to question how a reconfigured version of digital utopianism is informing an emerging socio-technical vision and practice of biology and biotechnology as a personal technology. In the first chapter, I proposed that social media as a technology of realization was instrumental in determining the meaning of a do-it-yourself biology. I argued that, in the uncertainty of establishing their socio-technical project, DIYbio members found in social media, and in particular in blogs, places where they could collectively elaborate their identities, and tools to immortalize and disseminate their socio-technical vision. Moving out of social media, this second chapter proposes to diffract once more the story of DIYbio's origins, this time by tracing its making offline. Such displacement reflects the central question of this chapter: which type of initial locations and hands-on practices did the members of the DIYbio network engage with?

In the literature, scholars focus on 'doing DIY,' understood as an amateur practice performed outside the professional organization of labour. A type of practice through which biology becomes a medium used to express the pleasure of doing DIY (Aguiton, 2010). The pleasure of doing DIY is also mentioned in Delfanti's work as an assimilation of hedonism, a trait he finds characteristic of computer hackers' culture (Delfanti, 2010). From a perspective that understood laboratory work as part of a long tradition of manual practices, Roosth instead proposes that DIYbio participate in a return of artisan and craft practice in biology – practices she frames through, among others, the writing of Claude Lévi-Strauss on the act of tinkering (bricolage) (Roosth, 2010: 110). Meyer, however, proposes that the 'creative workarounds' characterizing DIYbio practices have strong roots in the movement of citizen science (2012a).

In this chapter I intend to deflect the reader from these narrations and instead to consider DIYbio as part of a specific and expanding curatorial enterprise: the MAKE. The aim of such a large detour is to illustrate that categories such as hacker, amateur, citizen science, or craft, as used both by DIYbio members and scholars, should not, in my experience, be trusted as stable analytical categories nor as typical traits of DIYbio. Such a proposition does not undermine the classificatory efforts DIYbio has endured in the scholarly literature, but rather it is an attempt to situate such categories within contemporary organizations, actors, discourses and economies. As the overarching aim of this chapter is to reflect on the offline origin of DIYbio, such a proposition aims not to portray DIYbio members *only* as makers but *also* as makers.

The first snapshot therefore begins by questioning the composition of 'the maker' as a figuration and the representations of technology that are performed through it. To do so, the roles of three central actors are traced through an analysis of primary literature sources. These actors are Tim O'Reilly, CEO of O'Reilly Media Inc. and publisher of *Make Magazine*; Dale Dougherty, *Make Magazine'*s Editor and Publisher; and Mark Frauenfelder, *Make Magazine*'s Editor-in-Chief. In a context where the maker movement has not, to my knowledge, become the subject of ethnographic or sociological inquiries that situate its socio-economical demography or characterize its socio-technical vision,[1] those biographical portraits are an analytical choice aimed at both historicizing the figure of the maker and presenting archetypal identities that inhabit it. This first part is framed by Haraway's politics of figuration as 'performative images that can be inhabited' (Haraway, 1997: 11). The notion of the network entrepreneur as developed by Burt (2000) and adapted by Turner (2006a) is used to situate the culture of entrepreneurship embodied by O'Reilly, Dougherty, and Frauenfelder. Finally, I coin the term 'forum of manufacturing' to speak about the Maker Faire in reference to both Turner's use of the term 'network forum' and the notion that 'the festival becomes a factory' (Turner, 2006a and 2009: 89).

The second snapshot gives a preliminary analysis of *Make Magazine*'s issue 'Backyard biology.' It traces more broadly how biology has been included in *Make Magazine,* what is meant by backyard biology, and questions how biology becomes backyard biology. This analysis is informed by Roosth's work on the use of the term

1 A preliminary study of the Maker movement in China as been carried out by Silvia Lindtner (2012). Unfortunately her work does not include an historical section locating the emergence of the Maker movement.

'hack' to reference at biological materials (Roosth, 2010: 46). In order to describe the discourses and practices framed under the term 'backyard biology,' the concept of 'personal biologies' is coined and used with reference to Turner's work on how computers became personal (Turner, 2006a).

The third snapshot further analyses the content of *Make Magazine*'s issue 'Backyard Biology' by tracing the authors of its articles to professional science communication initiatives, and it illustrates how members of the DIYbio network were directly inspired by the content of *Make Magazine* and came to consider themselves to be makers. These questions are addressed through the analysis of participant observations conducted at two separate 2011 Maker Faires, organized in Newcastle (UK) and in San Matteo (USA) respectively, and are complemented with semi-structured, open-ended interviews with seven of the twelve members of the DIYbio network who, by that time, had participated in the Maker Faires as stall holders. The conclusion attempts to articulate Roosth's analytical category of constructive biologies (Roosth, 2010) in relation to that of personal biologies developed in this chapter.

First snapshot – Networking the MAKE

On the 29 July 2004, during the third edition of OSCON – O'Reilly Open Source Convention in Portland (Oregon) – Dale Dougherty and Mark Frauenfelder announced the imminent release of *Make Magazine* (*Make*), the last editorial creation of O'Reilly Media Inc. (O'Reilly Media). Rather than presenting the content of the soon-to-be-released first number, Dougherty explained how the project arose from a cab conversation with Tim O'Reilly. The CEO observed that there was not 'a Martha Stewart in the technology space – somebody who rediscovered and recovered crafts and gave them to a wider public.'[2] Dougherty noted that *Make* was meant as a drift away from 'cargo magazines' where readers are pushed to buy and not to manufacture, and a move towards the creation of one-offs at home, thereby advocating *Make* as a move from mass-manufacturing to individual manufacturing. For Frauenfelder, the project reminded him of the 'old Forties Popular Science,' a symbol of a time when it

2 Martha Steward the 'homemaking diva' represents the latest and most successful attempt to build an economic empire selling the idea and the tools for customers to perform a specific ideal of domesticity branded as a re-actualized discovery of grounding American traditions. For a historical account, see Leavitt (2002). These direct quotes, as well as the others references used in the paragraph, are taken from the notes of an attender of the OSCON presentation given by Dougherty and Frauenfelder. They were posted on <http://www.oblomovka.com/wp/2004/07/>. Last accessed 12 November 2012.

was cheaper to build than to buy; and he suggested that, for customized objects, that might again become the case. They invited those in attendance to share the projects they loved working on by publishing them in the magazine. This invitation was extended to Internet users, as on the same day Frauenfelder posted a short description of the *Make* launch on the *BoingBoing* blog, hoping that 'a lot of *BoingBoing* readers become *Make* contributors, too' by sending him ideas for articles (Frauenfelder, 2004). By being announced at OSCON, one of the largest and most fashionable professional IT and media networking events organized by O'Reilly Media[3], and on *BoingBoing*, an influential voice of the 'blogosphere,'[4] the magazine was placed at the centre of a particular techno-utopian legacy.

Tim O'Reilly Media Inc. and the legacy of the Whole Earth Catalog

O'Reilly and Associates was founded in 1978 as a technical writing consultancy firm and later became a publishing firm. The Boston-based company's first success came in 1992 with the publication of *The Whole Internet: User's Guide and Catalog*. Its story, framed as an inspirational lesson, is narrated in a book entitled *Creating Customer Evangelists: How Loyal Customers Become a Volunteer Sales Force* (McConnell and Huba, 2003). The authors describe how the innovative marketing visions of two employees, and Tim O'Reilly's receptiveness to them, established O'Reilly Media's model of customer evangelism.

Shortly before the release of the *Whole Internet*, Brian Erwin was hired as the director of public relations. Erwin's career path enabled him to combine extensive experience in book marketing, gained as an employee of two of the world's largest publishing companies, with the organizational activism of the Sierra Club – the most influential US environmental organization whose national media operation was established by Erwin (Young, 2008). In *Creating Customer Evangelists* O'Reilly explains that 'before [Brian], we would have just sent the book out to regular trade magazines′ (2003:115). Instead, Brian, who according to O'Reilly immediately recognized the potential of the Internet for communication, commerce and community,

3 In 2001 O'Reilly organized four conferences held exclusively in the United States. Ten years later, their number had grown to an average of twenty two conferences organized annually and worldwide. Available at: <http://conferences.oreilly.com/archive.csp>. Last accessed 12 March 2011.

4 According to Technocrati, a major website ranking service, the BoingBoing weblog 'It's the most popular blog in the world, and winner of the Lifetime Achievement and Best Group Blog awards at the 2006 Bloggies ceremony.' Available at: <http://technorati.com/blogs/www.boingboing.net?sub=tr_authority_t_ns>. Last accessed 24 October 2012.

launched what McConnell and Huba called a 'grassroots campaign,' sending copies of the book directly to 'key influencers' in the media and to a then-increasing number of newsgroups and mailing list moderators, inviting them to speak about the book to their users and readers. As Erwin recalls, 'it spread exponentially′ (ibid.: 116). O'Reilly explains:

> Brian really crystallized it for us because we were always part of a technical community. […] One problem is that marketing is seen as an adds-on as opposed to something that is intrinsic to the way you develop your products. While Brian got us to think about activism we were on very fertile ground because we were already seeing ourselves as a voice of a community. We were writing the books for a class of people we knew really well because we were them (ibid.:115).

The second lesson came from the 'grassroots activism' of O'Reilly Sales Director Jill Tomich, who was described as fostering a major sales increase by travelling from bookshop to bookshop, convincing their owners to establish a shelf dedicated to Internet and IT books. The *Whole Internet* became the first book to reveal to more than one million readers the revolutionary potential of the Internet, and its success provided O'Reilly and Associates with the financial leverage necessary to become O'Reilly Media Inc.[5]

The Whole Internet: User's Guide and Catalog does not only symbolize a landmark in the development of O'Reilly Media entrepreneurial evangelism (O'Reilly Media Inc., 2012): it is also the first expression of the O'Reilly homage to a specific vision of technology that has since become the trademark of the company and a legacy that *Make* has been designed to carry on.

In a post published in the O'Reilly Radar[6] to publicize an event co-hosted by Fred Turner and Steward Brand at the occasion of the publication of Turner's book *From Counterculture to Cyberculture – Steward Brand, the Whole Earth Network, and the Rise of Digital Utopianism,* O'Reilly expressed his personal relation to Brand:

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5 By 2010 the company, valued at nearly one hundred million US dollars, owned twenty-four percent of what is estimated to be a four-hundred million dollar market (Chafkin, 2010), selling each year more than one and a half million IT manuals, books and educational material worldwide (Hendrikson, 2011).

6 O'Reilly Radar - Insight, analysis and research about emerging technologies,' is a blog where the techno-futurology skills of Tim O'Reilly and his colleagues are made available to the IT community. Available at: <http://oreilly.com/oreilly/tim_bio.html>. Last accessed 10 April 2010.

> I'll add myself to their legacy. I didn't get to know Stewart till long afterwards, when O'Reilly was already a household name among geeks, but I nonetheless consider him one of my earliest and most important mentors. My first attempts to get published, right out of college, were some small articles that I sent to *CoEvolution Quarterly*, Stewart's successor to the *Whole Earth Catalog*. (A couple of them were accepted, but never published.) We shamelessly copied the name of the *Whole Earth Catalog* for our groundbreaking *Whole Internet User's Guide and Catalog*, but that's the least of our debts to Stewart and crew. A huge amount of the O'Reilly sensibility, a mix of practicality and idealism, was learned from the *Whole Earth Catalog* (O'Reilly, 2006).

More importantly, in the same post O'Reilly endorsed a future of this legacy by declaring: '[And] of course, the *Whole Earth Catalog* is one of the wellsprings of the modern DIY movement, for which *Make* is now carrying the torch' (O'Reilly, 2006).

In his book, Turner traces how computers, from being large, inaccessible machines identified with cold-war hierarchy and bureaucracy, were made into small-technologies, personal devices and networked tools capable of transforming consciousness. At the occasion of the cited event, he writes:

> Over forty years, they [Steward Brand and his colleagues] transformed American notions of technology and particularly, of computers. They shaped the defining notions of our digital world, including 'personal' computing, virtual community, and the vision of cyberspace as an electronic frontier. [...] And in the process, they transformed the ideals of the generation of 1968 into a deeply optimistic vision of the social potential of digital technologies (O'Reilly, 2006).

The inscription of *Make* as the carrier of the *Whole Earth Catalog*'s legacy is a strong symbolic claim. It invites members of the O'Reilly Media community of IT professionals to revisit or discover their relation to the history of personal computer and information technologies as tools for social change, while at the same time constituting *Make* as a forum in which to celebrate such a legacy.

Dougherty, the maker, and the myth of grassroots American innovation

Six months after being presented at OSCON, *Make's* first issue was released. In the welcoming editorial entitled *The Making of Make*, Dougherty wrote a more polished version of his socio-technical vision:

> More than mere consumers of technology, we are *makers*. [...] Make is a new magazine dedicated to showing how to make technology work for you. […] A Make project is rewarding and fun as an experience and it produces something that you can share with your friends and family (Dougherty, 2005: 7).

In January 2011, at TED@MotorCity in Detroit,[7] Dougherty further detailed the origins and the scope of his vision. In a talk entitled 'We are makers,' he narrated the myth of the maker from its origin to the present, announcing that he had a pretty simple idea and that he would repeat it all over again until everyone was be convinced that:

> All of us are makers, I really believe that, all of us are makers. We're born makers. We have this ability to make things, to grasp things with our hands. We use words like 'grasp' metaphorically to also think about understanding things. We just don't live, we make, we create things (Dougherty, 2011).

After having established the universality of the act of making for the audience, Dougerthy moved to a list of examples of the makers of today and their inventions. These included a bike composed of two bikes soldered one on the top of the other and called a 'scraper-bike', a drill powered mini-scooter, some electric muffin go-karts, electronic fabrics, 3D printers and 3D printed objects, non-military drones and autonomous vehicles, Arduino[8], and DIY space explorations. All the images he presented were taken during different Maker Faires, where, as he said, *Make* founders have 'started organizing the makers' (Dougherty, 2011). Dougherty explained:

> Makers today, to some degree, are out on the edge. They're not mainstream. They're a little bit radical. They're a bit subversive in what they do. But at one time, it was fairly commonplace to think of yourself as a maker (Dougherty, 2011).

To illustrate the last phrase he showed a fragment of a film collage entitled *American Maker* and produced in 1960 by Jam Handy Organization as a commercial visual communication for the Chevrolet division of General Motors. The film starts with a large view of a deserted beach, under a blue sky. The camera slowly focuses on two

7 TED@MotorCity event in Detroit is one of the local branches of TED. In a short article entitled 'Envisioning the Motor City, With or Without the Motor', published in the Automobile section of the New York Times, the journalist reported an atmosphere charged with an optimistic need to: 're-imagine Detroit, show that Detroit is not dying, and celebrate the role of technology in rebuilding the urban landscape' (Warren, 2011).

8 Arduino is 'an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects.' From the Arduino website, available at: <http://www.arduino.cc/>. Last accessed 4 April 2015.

lone white, male children who are putting the finishing touches on a sand fortress that harbours an American flag. A typical 50s-60s male narrator's voice explains: 'Of all things Americans are, we are makers. With our strengths and our minds and spirit, we gather, we form, and we fashion. Makers and shapers and put-it-togetherers.' While the yearning to make resonates powerfully with the Detroit audience, a city heavily hit by the consequences of 2008 financial crisis, Dougherty's closing remarks are characteristic of a specific ideal of economic revitalization, as he claims: 'What will America Make? It is more Makers' (Doughery, 2011).

By mobilizing images of American middle class Do It Yourself (DIY) culture as represented in the short film, Dougherty anchors the maker to a powerful myth, that of USA homemade innovation and manufactured self-sufficiency. As these images participate in the mediation of social relations, the maker as a relational identity becomes a spectacle[9]. By using the figure of the maker, Dougherty infused the magazine with evocations of the mythical imagery of a conservative American society united in what became the foundational act of manufacturing.

Dougherty is also the conceiver of the Maker Faire, a two-day fair dedicated to the celebration of the 'maker mindset.' The first Maker Faire took place in April 2006 on the San Mateo Fairgrounds, at the heart of the San Francisco Bay Area. Only five years later, more than twenty Maker Faires and Mini Maker Faires had been organized across the USA, Canada, UK, Ghana and Egypt. According to organizers, the 2011 Bay Area Maker Faire was visited by more than 70 000 attendees. On the event website, Maker Faire is presented as 'the premier event for grassroots American innovation. [...] The World's Largest DIY Festival. [...] A showcase of invention, creativity and resourcefulness and a celebration of the Maker mindset' (Maker Faire, 2012). In a short article entitled *Genuine Ingenuity* and published in the *Make*'s issue Backyard Biology, Dougherty writes about his experience as an organizer:

> The new interest in DIY is more than just fun; it is part of a deeper search for authentic experiences, something our contemporary culture just doesn't offer enough of. Maker Faire was highly engaging. Unlike so many tech events, there was no one sitting in a corner with a computer checking email or Iming someone. Everyone was fully present, in body and spirit, kids and adults alike

9 The word 'spectacle' is used here to refer to the hypnotic relations based on images that highlight certain elements of more or less fabricated reality while explicitly or implicitly obfuscating others. As such it is loosely inspired by Debord's concept of spectacle as a critique of the relationship between representation and consumption (Debord, 1992[1967]).

(Dougherty, 2006, p.48).

Isolating instant messaging (Iming or IM-ing) becomes an anecdotal fragment of what Dougherty critically experiences as a form of digital disembodiment, and Maker Faires constitute the place where the family, friendly and bonding experience of 'grassroots American innovation' becomes its antidote. Similarly to the way that Fred Turner describes the relationship between the Burning Man festival (which statues and installations are also showcased at Maker Faire) and Google employees with the expression 'the festival becomes the factory' (Turner, 2009: 89), it is possible to speak about the Maker Faire as a forum of manufacturing where social networks are formed around the promises of small-scale manufacturing. As such, a 'deeper search for authentic experience' becomes an attractive welcoming message on the maker's 'home': the Maker Faire.

Figure 3.1 The making of the the makers: portraits.

On the top, from the left Dale Dougherty and Tim O'Reilly immortalized for an article about *Make* in Forbes (Corcoran, 2008). The second image, is a reproduction of Mark Frauenfelder's cover of his book – see next section (Frauenfelder, 2010).

Frauenfelder a superstar blogger who makes to unplug

Frauenfelder first became known among members of the cyberpunk subculture as the co-founder, with his wife Clara, of the zine[10] *bOING bOING*. In 1989, he swapped

10 Common abbreviation for the term fanzine that became referential in the scene of independent

what he describes as an extremely specialized job as a parts engineer, with the hectic world of freelance zine writing and publishing. Frauenfelder recalls that being in charge of the entire production process and creating a space where they could explore and share the 'coolest, wackiest stuff' they could think about was at the core of their motivations (Rowe, 1997).

bOING bOING covered classical zine themes such as self-publication, pirate radios, bizarre forms of worship, cyberpunk literature and LSD. Mathieu O'Neil who analyses the discourses of zines in the San Francisco Bay Area (1980-1995), describes zines as a type of media whose content is characterized by the expression of extreme and often marginal subjectivities and where authors position themselves as an alternative and revelatory information source to mainstream media and its conventional representations (O'Neil, 2004b). Though fitting such a description, *bOING bOING* manufacturer's mark was the combination of classical zine themes with less common themes such as cryptography, nanotechnology, rocketry and software politics.

In less than four years *bOING bOING* grew into a zine with a 17 000 copies in distribution; and in 1996, an enlarged *bOING bOING* editorial team pioneered the Weblog boom by inaugurating a blog with the same name. *Boingboing.net* quickly became, and still is, the blogosphere's most read blog while Frauenfelder and his colleagues are often portrayed as 'superstar bloggers′ (Hammock, 2005). The tradition of the zine as a 'personal media' (O'Neil, 2004a: 47) passed over to its 'digital descendant.' Meanwhile, Frauenfelder continued to develop his career as a freelance writer by working for what Turner (2006a) defines as different stages of the techno-libertarian media part of the Whole Earth Network: the *Whole Earth Review*, *Wired*, and *Wired Online* (of which Frauenfelder was the founding editor-in-chief).

In 2005, Frauenfelder became Editor in Chief of *Make*. In his last book, entitled *Made by Hand: Searching for Meaning in a Throwaway World*, he narrates how the job offer coincided with a second major turning point in his life. In 2003, as the freelance-journalism market in California was hit by the dotcom recession, he and his wife decided to leave the 'over-caffeinated routine of school, work, driving, takeout meals and weekends filled with kiddie birthday parties' life of Los Angeles and move to Rarotonga, a small island in the South Pacific (Frauenfelder, 2004: 1). Frauenfelder

publication (O'Neil, 2004a).

describes how by baking their bread, picking up coconuts from the garden and spending their days cooking, they also learned 'how to slow down and to take more control over the systems that kept us alive and well' (Metzger, 2010). Yet only four months later they moved back to Los Angeles and returned to their previous routines. At the same time that Frauenfelder was offered a job as the Editor-in-Chief of *Make*, he became involved with the maker community, 'hanging out with people who do this not just with food but with everything' (Metzger, 2010). He started keeping bees and chickens, made his own yogurt, and constructed guitars out of cigar boxes and robots from discarded computer mice (2010). These, 'analogue activities' as Frauenfelder called them, became his way to 'unplug' - to 'cut through the absurd chaos of modern life and find a path that was simpler, direct and clear' (Frauenfelder, 2004: 2).

After becoming *Make*'s Editor-in-Chief, Frauenfelder was offered the possibility of networking *BoingBoing* readership and their techno-libertarian editorial style with the O'Reilly Media community of IT professionals. More importantly, Frauenfelder helped frame analogue activities as tools to unplug from the speed of hyper-digital societies and the disembodiment experiences of perpetual informational connection. What Sarah Franklin named a 'back-to-the-tool' experience[11] can be understood as a contemporary rewrite of the need to escape from the latest fall-back from the techno-utopian search for emancipation as it is felt by an increasing portion of founders and inhabitants of the digital generation.[12]

Over the years, the magazine and the Faire grew into a network of interlinked initiatives called 'the MAKE', described on the 'about' tab of the award-winning Makezine website:

> MAKE unites, inspires, informs, and entertains a growing community of resourceful people who undertake amazing projects in their backyards, basements, and garages. [...] The MAKE audience continues to be a growing culture and community that believes in bettering ourselves, our environment,

11 Personal conversation, 1 December 2011.

12 Traditionally the analysis of what is described as information overload and disembodiment tends to be the subject of the sociology and psychology of addiction. For an introduction to this, see Gackenbach (1998). More generally, the relationship between information, acceleration and disembodiment has been described by several scholars among the first of these is Virilio (1986). In the last five years the theme of unplugging has been emerging as a collective attempt to redefine our relationship to communication technologies. An iconic example is the call for a National Day Of Unplugging: 'With roots in Jewish tradition, this idea of taking a tech detox as a modern day of rest was developed by Reboot as a way to bring some balance to our increasingly fast-paced way of life and to reclaim time to connect with family, friends, the community and ourselves' (Sabbath Manifesto, 2010). Others refers to it as a 'digital detox' (Sieberg, 2012).

> our educational system — our entire world. This is much more than an audience, it's a worldwide movement that Make is leading — we call it the Maker Movement.

Other than the website described as 'one of the most popular online watering holes for makers, crafters, inventors, tinkerers, and amateur tech and science nerds of all stripes,' MAKE includes the Maker Shed, an online store selling 'projects in a box otherwise known as kits' described as 'the coolest, nerdiest bookstore, museum gift shop, arts and craft shop, and electronics emporium you can possibly dream up — now roll them all into one' of which a 'pop-up' version is present at the major Maker Faires. And there is a whole social media branch composed of Make Blog, Make Television and several Web 2.0 applications such as Facebook, Twitter and Rich Site Summary (RSS or Really Simple Syndication) reporting from the world of MAKE. Following these statements, MAKE can be understood as one of the latest examples of what Turner, in reference to the Whole Earth Network, named a 'network forum' (2006a: 5): a series of meetings, publications, and digital networks 'drawing on the systems rhetoric of cybernetics and on models of entrepreneurship borrowed from both the research and the counter-cultural worlds' (ibid.: 5). A network forum where professionals and researchers in the IT sector, entertainers, business leaders, computers hackers and tinkerers 'can imagine themselves as a single community' (ibid.: 5).

This first snapshot captures the maker as a complex and composite figuration. By their individual and combined efforts, I argued that O'Reilly, Dougherty and Frauenfelder entrepreneurially networked the implosion of what Haraway calls 'semiotic-material fields' (Haraway, 2007: 190) – in this case, namely, the legacy of the *Whole Earth Catalog*, the spectacle of grassroots American innovation, and a digital generation in search of carefully negotiated, unplugged socialities. MAKE as an information technology is a scaffold from which the myth of the maker can be constructed and to which contributions can be made. This follows from Leo Spitzer's proposition, according to which 'the linguistic creation is always significant, and one must say, conscious' (Spitzer, 2005 [1970]: 51). To paraphrase him, in the history of the linguistic and material creation one can find the cultural and psychological diagnostic of a social group at work (2005 [1970]: 52). As in the magazine and the faires, the term 'maker' is used as a synonym for tinkerer, hacker, geek, technologist,

crafter, citizen scientist, amateur, innovator, and fabber;[13] it becomes the synchronic extension of the maker figuration and works as a semantic umbrella, a linguistic term used here to designate the network of relationships and processes that converge in the maker. By extension, the diachronic depth of 'the maker' builds on the ontological power of the conservative myth of 'American grassroots innovation' as a recent chapter in the cultural history of manufacturing in the United States.[14]

Maker Faires have become one of the main homes of the maker. They serve as a forum of manufacturing, where the experience manufacturing is re-discovered collectively. More broadly, *Make* and Maker Faires are both the tools and the product of a curatorial practice. The evangelical role of O'Reilly Media, similar to the applied conservation biology of the Sierra Club, is designed to curate makers' communications and gatherings as natural and national resources of innovation. By catalysing, once more, the implosion of hobby and innovation, spare time and work time, the maker embraces the entrepreneurial responsibility of transforming his or her house into an innovation and business incubator.

13 A shortening for fabulous, in this context use to indicate a person who fabricates.

14 The expression 'cultural history of manufacturing', refers to the myth of manual creation, craftsmanship and tool production as a fundamental trait of manhood see Heiddeger (1977). In the context of MAKE, the maker is the craftsman, but his economy is the one of the prototypes of a transition object such that, while performing that which symbolises the unique, kits produced in low number of copies can also potentially be integrated as part of mass manufacturing pipelines. For Dougherty's description of such ideal see 'Foxconn, Makers, and the Future of U.S Manufacturing' (Holbrook, 2012).

Figure 3.2 The home as an innovation and business incubator.

From the top, a portion of the cover of Carolyn Goldstein's book *Do it yourself: Home improvement in 20th Century America* (Goldstein, 1998). Below 'the modern DIY,' the image (unknown author) was used to illustrate the book review of *Makers: the new industrial revolution* published by Chris Anderson for Forbes on October 2012. The review was written by Daniel Grushkin a *Bloomberg BusinessWeek* contributor, and one of the co-founders of Genspace, the first DIYbio 'community laboratory' based in New York (Grushkin, 2012).

Second snapshot – Backyard biologies as personal biologies

One year after the first edition of make *Make*, an issue of the magazine entitled

'Backyard Biology' was published. In it several projects where materials such as small fish, snails, strawberries, DNA, plants' sexual organs and mushrooms were laid out with the appropriate tools and instructions. Its title, and more importantly the cover's composition, marked a first and important distinction.[15] A close-up image portrayed two impersonal hands: one holding a lily while the other holds a pair of tweezers near the lily's stamen (where the pollen is stored). The picture depicted the act of removing the stamens, (an act described by the editors as 'emasculation - ouch'), which is a step sometimes required before hand pollination. The choice of the impersonal hands is considered as a graphical technology associated with the emergence of modern science, and understood as representing the universal possibility of participation (Panese, 2003). In this context, the image is also a visual celebration of how the maker performs once more as an umbrella term. This is, in fact, a first for *Make*; the medium upon which the act is performed is not an electro-mechanical device, but a colourful and imposing flower. The maker and the lily form a new and peculiar figurative pair whose relation needs to be explained.[16] The image is therefore combined with the exhortation 'hack your plants' and followed by the proposal of 'nine backyard biology projects.' Hand pollination, a classical technique used in horticulture since the 19th Century, is turned into a 'hack' and 'hacking' plants becomes a 'backyard biology' project.

15 Historically biology, and biotechnology in particular as a 'hands on science,' have only experienced rare incursions in the pages of science vulgarization journals, and even more rarely in popular DIY magazines. One of those rare examples, as Luis Campos illustrates, was the presentation of plant hybridization techniques in Popular Mechanics, the major USA popular science magazine. Campos argues that "in fact by the 1940s and the 1950s an entire realm of amateur backyard biology, the horticulture predecessor of perhaps today DIY synthetic biology had emerged. The magazine Popular Mechanics was referring to 'modern plant engineering' already by the 1940s and to an era of 'chemical plant engineering' beginning. There was a general public interest in a new technology to create or to engineer living things in one's backyard" (Campos, 2011).

16 The other modes under which the 'living' as a medium has made its appearance in the pages of *Make* magazine is as a part of gardening, energy and waste management projects. In order to be portrayed in the magazine, those activities are re-purposed and portrayed according to the technological vision of *Make's* editors, as small-scale, open source and personalized tools. Activities such as urban farming are made into 'Geeked-out gardening' using the Garduino, an Arduino controlled plant watering system, while energy management is practiced through a dedicated Web-based interface to manage solar panels, or with open-source networked gadgets inspired by home automation technologies to keep track of household energy consumption (*Make* Issue 19 'Remake America,' 2009).

Figure 3.3 Backyard Biology.

Make's Issue 'Backyard biology' among the covers of other Issues, and a zoomed version highlighting the headings: 'Hack your plants – 9 Backyard Biology projects' and 'Extract your DNA.'

Although the compound noun 'backyard biology' has not yet been inscribed in dictionaries, a search for the term on the Internet indicates that it is mostly used by actors in the field of education and environmental awareness. In this context it refers to a subset of outdoor activities for children and young adults concerned with the scientific observation of living organisms and natural phenomena in areas of proximity, where urban and natural elements coexists. The term is also used, though much less rarely, in reference to the activities of particular citizen scientists in the fields of ecology and population studies (Reece, 2011) and in conservation biology research projects involving gardening practices (Galluzzi *et al*., 2010).

The backyard itself, as a place of instrumental exploration and production has been part of *Make* since its first issue. For example, the column 'Made on Earth: Report from the world of backyard technology,' is entirely dedicated to the presentation of makers' activities practiced in the domesticated exterior of the backyard. Projects such as glass artwork inspired by mould, viruses and plants, wine making, wheelchair design from readily available parts and kinetic sculptures are among the 'amazing things that ordinary people are making in their garages and backyards.'[17]

The relation between domesticity, technologies and work is an extremely vast area of study. Goldstein's historical account of Do-It-Yourself home improvement in 20th century America, illustrates that 'for many American families, home-improvement activities provided a way of obtaining the house and lifestyles to which they aspired – a way of participating in the American dream' (Goldstein, 1998: 37). As part of this continuity, the backyard becomes an additional place where a hands-on domesticity is performed. The appropriative activities of the maker mark the threshold between the mass-produced and impersonal purchased objects, and personal home-made ones. Like basements, workshops, garages, and kitchens, backyards are also celebrated as a place of homemade innovation and not only as one for storage and leisure. Given this preamble, how is the category of backyard biology used in *Make*?

Making biology into backyard biology

Although not directly inscribed in the section 'Backyard Biology,' on page forty-two the front page exhortation to 'hack your plants' is expanded to bugs, 'living stuffs' and biology at large. In a section entitled 'Proto - Profiles of corporate Makers who have managed to parlay their hacker sensibility into a career,' Drew Endy, a leading figure in the emerging field of synthetic biology, is profiled.[18] The piece, entitled 'Garage Biotech,' describes Endy as irritated by 'bugs' as objects that 'should be editable' and asking the question 'Why can't I just hack this stuff?' He concludes with a comment that sounds almost like a wish: 'if engineers can only see that biology is simply another substrate to hack' (Parks, 2006: 42). Through the words of Endy, engineering biology

17 From the webpage where all the articles of the column Made on Earth are archived. Available at: <http://makezine.com/made/>. Last accessed 3 May 2010.

18 As briefly mentioned in the introduction, synthetic biology is a recently emerged discipline aimed at applying engineering principles in biology in order to enable a more standardized manipulation of living organisms (Endy, 2005). For an ethnographic account of synthetic biology and in particular in Endy's role promoting an 'hacker' and 'open souce' ethos, see Roosth (2010, Chapter 2).

as hacking becomes part of *Make* and is disseminated through it. As Endy explained, 'there's a visceral satisfaction to making a physical object. But the first time I cut and spliced a piece of DNA, I felt the same joy of making something. I was like, 'Holy crap! It works!' (2006: 3). As the eleven pages separating Endy's portrait and the Backyard Biology Special Section are filled with the journal's usual content, backyard biology and engineering biology as a 'hack' simply becomes an additional type of making among those portrayed in the magazine. Roosth, who traces more closely the role of Endy and his colleagues in the displacement of the term 'hack' from computer engineering to biology, argues that since synthetic biology has conditioned the formation of the DIYbio network. The term 'hack,' she explains, is use as a synonym of a construction-oriented biology is a foundational gesture that also organizes the DIYbio network (Roosth, 2010). In conversation with her work, I would like to suggest that by following 'hack' as it has been recently included under the maker's umbrella, a different history of the biologies produced by DIYbiologists could be highlighted.

Colourful pictures and illustrated instructions inspired by modern graphic design bring up-to-date a rather traditional representation of technoscience. In the first article entitled 'Life and Death at Low Temperature,' cryobiology is portrayed as an activity transgressing boundaries by 'challenging conventional concepts' such as death (Platt, 2006: 55). In the first and second articles, the figure of the 'solitary' and anti-institutional scientist/maker is opposed to the institutionalized elitist expert who is not to be listened to (Platt, 2006: 55). 'The Kitchen Counter DNA Lab' details the instructions on how to unveil the 'extraordinary and miraculous blueprint of life itself,' with only salt and soap (Shawn, 2006: 59). While in 'Home Molecular Genetics,' the authors explain how to construct homemade laboratory equipment such as an electrophoresis chamber out of Tupperware and Lego building blocks, and a thermal cycler made with cheap electronic components (Nakane *et al.*, 2006). The agency of horticulture is exhorted to 'hack your plants!' (Luhn, 2006: 71), and finally, the fabrication of a sterile hood out of a plastic box and a HEPA filter used to cultivate mushrooms is portrayed as a 'cultural revolution' (Ross, 2006: 100).

Clearly the imagery of the backyard is no longer only a place where the backyard biologist can meet 'living creatures with interesting stories to tell' (Backyardbiology.org, n.d). It becomes a place of experimentation and production

where life and death can be given or taken; the blueprint of life itself can be duplicated and analysed. When the act of making is technologically weak, as in the case of grafting and hand pollination where few tools are required, it is reinforced by being referred to as 'hacking.'

In the act of crafting biology into a subject of interest for *Make's* readership, the relation with biological material needs to be mediated by the fabrication of small-scale and homemade laboratory tools. The labelling of cryobiology, molecular biology, horticulture and mycology as 'backyard biology' extends to the biological the aim of *Make's* editor and publisher of 'adapting technology to our needs and integrating it into our lives' (Dougherty, 2005). Some authors in the section also claim that it is possible for 'everyone' (in the journal readership) to become a 'backyard cryobiologist' and a 'backyard biologist:' an actor of techno-scientific progress who does not only read and appreciate progresses made in the area of biology and biotechnology or only reproduces outdated experiments, but participates by gathering and assembling the tools to carry out those experiments and potentially inventing new ones. By focusing on the fabrication of research tools, and actually giving only little information about the knowledge of biology, backyard biology becomes a laboratory of self-sufficiency where the progress of technoscience can be experienced through a personalized participation mediated by small-scale technologies. Biology thus enters the home from the backyard and becomes a material for personal experimentation. As such, the yet-to-be clearly localized device of the home laboratory joins basements, kitchens, home workshops, Hackspaces and garages as sites of domestic production, all of which are part of the editorial project of O'Reilly Media: the entrepreneurial conservation of grassroots American innovation.

This second section proposes that, within *Make*'s pages the informational and digital epistemology of biology has again mutated. The use of the term 'hack' to refer to a way of interacting with living material could be interpreted as yet another move towards what Haraway, among others, describes as the 'translation of the world into a problem of coding, a search for a common language in which all resistance to instrumental control disappears' (Haraway, 1991: 164).[19] In synthetic biology the use of the term 'hack' stands for a double attempt. On one side, it stands for the paradigm of the living as information and software. A paradigm that is extended and actualized

19 See also Rabinow (1992), Helmreich (1998) and Fox Keller (2002).

under the contemporary discourses and practices of open-source software and hardware, including new forms of trafficking involving socialities rather than concepts and theories (Roosth, 2010). On the other side, the living, as a material to be engineered, becomes hardware. In order to analyse this movement Roosth suggests that a shift from the cyborg as a useful analytical category to that of open-source software, which is 'modifiable, shareable, collaboratively written, ubiquitous,' might be necessary (2010: 108). In this section, I have described how the category of backyard biology becomes the recipient of displaced biotechnological bodies that, together with the small-scale laboratory, become a new tool placed into the maker's hand. Following on this, I would like to suggest that the cyborg and its politics of kinship are still a very useful analytical figure. What has changed and been displaced are cyborg's mode of production and composition, the information:machine:biology recursive assemblage has become open source software:open hardware:personal biology. In this respect, maker's cyborgs are still the products of the same technocultural endeavour; but similarly to how computers transitioned from institutional to personal, the maker is now developing the language, the tools, and the spaces to think about the production of cyborgs as personal. In the pages of *Make* biology not only enters into the house of the maker, it enters a house portrayed as an innovation and business incubator. Staying with the metaphor of the incubator, and borrowing Haraway's words, the house of the makers can be understand as a 'breeder reactor' in progress (1997: 55), a place where the experimental promise of small-scale technologies and the creative materiality of biology are portrayed as domestic.

Nevertheless, the activities portrayed in the backyard biology section did not become part of the iconic projects that distinguish *Make* from the other magazines. In the following years, activities making reference to biology and biotechnology were only given a marginal space on the *Make* blog. Only recently, in the thirty-first Issue, published on October 2012 and entitled Punk Science, several projects from DIYbio members were presented (Make Magazine, 2012). Instead, as the following section illustrates, backyard biology and the projects portrayed in *Make* reappeared in the first inspiring presentations given by MacKenzie Cowell, DIYbio co-founder, and were used as the first hands-on activities pursued by DIYbio members.

A less counter-cultural detour?

Before concluding this second snapshot, I would like to draw the reader's attention to two articles published in the Backyard Biology issue. As we will see in the last section of this chapter, the activities demonstrated in these articles actually became the first hands-on demonstrations performed by the early members of the DIYbio network. They were used as an example to show that a Do-It-Yourself biology was possible, and, more importantly, as an example that was supposed to demonstrate that by following the instructions in the articles a Do-It-Yourself biology was, do-able.

The first activity, entitled 'Kitchen Counter DNA Lab,' was proposed by Dr. Shawn and described him as follows: 'Dr. Shawn (Shawn Carlson, Ph.D.) is a MacArthur Fellow and the founder and executive director of the Society for Amateur Scientists.' In an interview published by the New York Times, Shawn is further described as 'an unhappy physicist working in a mainstream laboratory decides to quit his job and start a nonprofit organization aimed at encouraging the projects of backyard tinkerers and garage experimenters.' (Dreifus, 2001). Shawn's commitment to change institutional science turned into his advocacy for amateur science, as a place where truthfully creative work can still be done.

The first half of the page was occupied by the large title, and a subtitle: 'Extract, purify, and experiment with the blue print of life.' On its second half there was a picture of an Old Fashioned Glass glowing with its lightning effect, and filled up to one third with a slightly green and transparent liquid. Photographed against a black background, the area beneath the surface of the liquid was crossed by a black band, thus highlighting the snowflake-like aggregate floating in the liquid: 'the blue print of life.' Such rhetoric was further amplified in the paragraph addressing the reader. In it, the trope of DNA as the molecule of life was fully uncoiled. DNA '[is] perhaps the most extraordinary structure in all creation. Its famous double helix is the longest molecule known and regulates the life processes in every cell on Earth,' wrote Dr. Shawn (2006: 60). Having established DNA as the site of universal kinship, he continued by rooting it in the geological time of evolution: 'this miraculous winding staircase directly links every creature on Earth to our ancient and common past' (ibid.: 60). As for the figure of 'the maker' that according to Dale Dougherty we all are and we have always been, DNA is similarly presented as a site of universal kinship, both synchronic (i.e we all have DNA now) and diachronic (i.e we always had DNA).

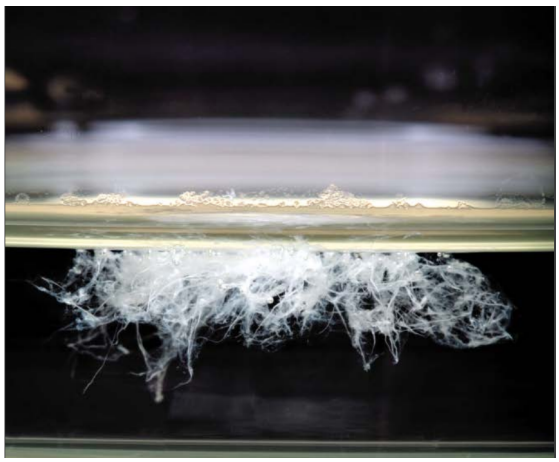
Having set out such bidimensional universalism, the paragraph abruptly turned a story of exclusion into a happy ending. The author wrote:

> The properties of this massive molecule are so mysterious and wondrous that most folks assume only the enlightened priesthood of laboratory biologists can extract and study it. Not so. In fact, anyone can extract, purify, and experiment with DNA at home (ibid.: 60).

Finally, the article claimed that an experiment would demonstrate that, in fact, not only can one experience such doubly universal kinship inside the comfort of his or her home, but also that such an experience could belong to anyone. Eager to move to the demonstration, the last paragraph only briefly explained the chemistry underlying the demonstration. The remaining four pages of the article showed the instructions punctuated with large and stylized pictures of shining glasses, and snowflakes of DNA.

For each step, directive titles were chosen: 'Build the Buffer,' 'Get the DNA,' 'Dump the Gunk' (the part of the sample to be discarded) and finally 'Extract the DNA' Explanations, addressed the reader as 'you,' and pleasantly combined cookery-like-instructions with descriptions using rather technical terms such as ions and enzymes (ibid.: 62). At last, the author wrote: 'Where the 2 liquid meet, a gelatinous sludge will suddenly appear. That sludge is DNA!' (ibid.: 62). Awkwardly, in everyone's kitchen, out of the hand of the enlightened priesthood of laboratory biologists, the blueprint of life has turned into sludge. The experiment seems to demonstrate something rather different from what was intended, which was the turning into sludge of the noble molecule. Maybe the glamour of DNA is not to be found in the molecule itself, but *in* the enlightened priesthood of laboratory biologists and their capacity to extract it in its chemically pure form, or to represent it as an abstract model looking like a staircase to heaven; not like a sludge. The description proposed that to pursue the experiment by learning how to quantify the 'harvest,' the reader should turn the page, there a zoomed-in image is revealed a more dignified representation of 'the sludge.'

Figure 3.4 DNA at home: a portrait.



The sludge of DNA in a 'dignified pose.' On the bottom of the page instruction on how to dye DNA to see 'your entire harvest' are printed.

The section 'Taking it further, DNA experimenting' is about bringing the 'adventurous experiments' a step further. Dr. Shawn describes to 'you' how to measure the amount of DNA extracted, but also how to 'run experiments with the DNA itself,' by testing different factors (chemicals, sunlight, and temperature). In a discursive gesture which reads as being aimed at reducing the gap between the expectations and the reality of the experiment, the article concludes by explaining that it is with practice that one gets consistent results, and that one must be sure 'that your plotted data shows a regular behaviour before drawing any conclusion' (ibid.: 64). This concluding remark establishes a productive continuity between the wondrous demonstration proposed in the article and the performing of rigorous scientific experiments. This, I argue, is a productive continuity upon which Dr. Shawn relies to encourage amateur science, backyard tinkerers and garage experimenters to practice science beyond the limiting experience of mainstream laboratories. To further enable this possibility, in a final bit of boxed text, we learn that 'as a special service to MAKE readers, Dr. Shawn has assembled a kit that contains everything you need to perform at least 20 DNA experiments' (ibid.: 64), the kit can be ordered by phone or online.

The second experiment, the 'McGuyver project,' portrayed in *Make* under the title 'Home Molecular Biology' was conceived in 2005 by members of the Advanced Molecular Biology Lab from the University of British Columbia (AMBL) (Nakane *et al.*, 2006).[20] On their website, the Advanced Molecular Biology Lab is presented as a

20 The article, entitled 'MacGyver project: Genomic DNA extraction and gel electrophoresis using everyday materials,' was first published in the *Science Creative Quarterly*, an online magazine

research unit specialized in science education programs and regarded as 'the educational arm of the Michael Smith Laboratories.'[21] On the website the research unit is described as being 'conceived by Smith to provide life science learning experiences for both general public and scientific communities.' also describes AMBL as having 'made a name for itself by often using creative and unconventional avenues of science communication, particularly where the intersection of science and other disciplines is explored.'[22]

If, in the first experiment, it was the priesthood of laboratory biologists that the experiment intended to challenge, the second proposed that DNA fingerprinting is not only for 'the lab of CSI, agribusiness, and headline-grabbing research institutions.' Thanks to the explanation given in the articles, 'You can even do it at home' (Nakane *et al.*, 2006: 65). This second experiment was separated into two parts. Part one 'explains you how you can isolate and 'fingerprint' some of your own DNA (which is easy).' The second detailed how to 'replicate enough of it to perform more accurate and detailed fingerprinting (which is a bit more difficult)' (ibid.: 65). The introductory paragraph concluded by explaining to the reader that 'You can view these experiments as an extension of high school education, a low-cost contribution to science infrastructure in developing countries, or perhaps even an exercise in bioethics' (ibid.: 65). For the first experiment, again paragraph titles used directive expressions such as: 'Extract the DNA' or 'Make the Gel Box.' Similarly, the article mixed common language with technical terms. For instance, measures were described both in millilitres, and 'tsp,' for table spoon. The first experiment proposed 'genotyping' in quotation marks. The punctuation mark indicated that the experiment was only an approximation of the “Real DNA 'fingerprinting' proposed in the second part” (ibid.: 67). The expectable result, a blurred stain on a gel, was described as 'not good enough,' and the reader was invited to turn the page to do the real DNA 'fingerprinting' by building a PCR system. In the second article, the authors struggled to provide the reader with complete explanations. Additionally, as a majority of Make readership is knowledgeable in basic and advanced electronics, the explanations were marked by

edited by the Advanced Molecular Biology Lab. Accessible at: <http://www.scq.ubc.ca/the-macgyver-project-genomic-dna-extraction-and-gel-electrophoresis-experiments-using-everyday-materials/>. Last accessed 13 November 2012.

21 Michael Smith was a chemist and an influential researcher in genetics, widely known for the developed site-directed mutagenesis for which he won the Nobel Prize for Chemistry in 1993.

22 Available at: <http://www.bioteach.ubc.ca/about/>. Last accessed 13 November 2012.

the use of terms which were taken for granted, such as 'P-type and N-type semiconductors'[23] or Burr-Brown OPA 4241PA'[24]. The reader is repeatedly referred to an hyperlink from which to access the schematics and the full list of the parts required for the project. The degree of simplification, mixed with the use of technical terminologies, redefines the universal 'you' that the authors are writing for. Designed by scientists with an interest in science education, the second experiment, like the first, is an invitation to join science by any means, including the ones made available in the article.

After emerging from research laboratories where DNA extraction, gel electrophoresis, and DNA amplification were used by researchers only, these techniques are now presented in the Backyard Biology issues, since they have made a long journey. Progressively, DNA extraction, gel electrophoresis, and DNA amplification have been used by a constantly increasing number of first postgraduate, then graduate and undergraduate students. More recently, following governmental and industrial recognition of life sciences as a major area of investment, especially in the United States, these techniques have also been introduced as part of the science curriculum in secondary education. Similarly, their demonstration has progressively been included in public and private science educational initiatives. In particular, these techniques have been adopted by science museums and science festivals organisers who have come to value 'immersion' using hands-on laboratory experiences as a science communication practice. Nowadays, several hands-on DNA explorations kits can also simply be purchased online.

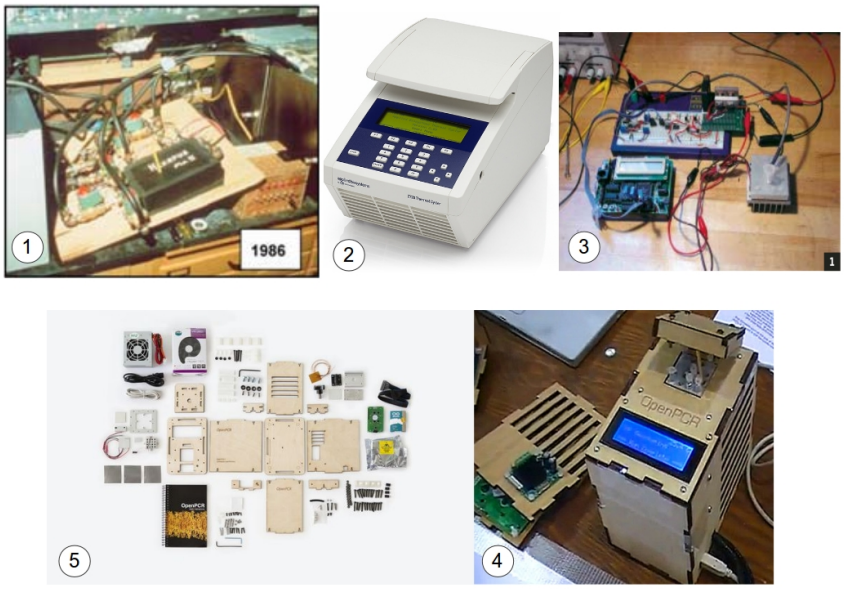
Focusing on the example of the PCR, the image (Figure 3.5) aims at illustrating that the PCR has completed yet another amplification cycle: not the one of recursively duplicating DNA strands, but one of recursively replicating the experience of prototyping the machine itself. In his ethnography tracing the making of the Poly Chain Reaction (PCR), Paul Rabinow illustrates that researchers came to determine what PCR was, by learning how to use it (Rabinow, 1997). By travelling, the acknowledged uses of the PCR, but also of DNA extraction and the gel

23 P-type for positive, and N-type for negative, semiconductors are the basic components of modern transistors, the basic unit of electronic chips. The semiconductors work by reacting differently to an electric charge and and thus resulting in the transistor being turned on (representing 1 bit) or off (representing 0 bit).

24 Burr-Brown are one of the largest online networks for buyers and vendors of electronic components mostly manufactured in China and Hong Kong. The OPA 4241PA is an OPerational Amplifier, an electronic component that converts a low voltage input into a high voltage output.

electrophoresis, become susceptible to mutation. From universities to science museums events and explorations kits, these can be considered glimpses of a distinct practice in science communication, a practice that, borrowing and adapting Latour's term, might be called a *science communication-in-action.*[25]

Figure 3.5 The Poly Chain Reaction amplification cycle.



The image shows: 1) The prototype of a PCR machine realized by Oliver Smithies[26] and co-workers in 1986 before any PCR machine was commercially available. 2) A standard PCR machine purchasable from Applied Biosystems®, a major supplier of laboratory instruments, for £3,111. 3) The PCR machine as presented in Make Magazine and below the OpenPCR, an alternative developed by members of the DIYbio network (see next section) and purchasable for $599, shown assembled (4) and displayed as an Ikea-like project (5).

25 In 1995 the US National Academy of Science in conjunction with the National Research Council released the revised version of the National Science Education Standard. These standards called for a departure from theory-based curricula to a much more 'hands on' approach: "Learning science is something students do, not something that is done to them. In learning science, students describe objects and events, ask questions, acquire knowledge, construct explanations of natural phenomena, test those explanations in many different ways, and communicate their ideas to others.' In the *National Science Education Standards*, the term 'active process' implies physical and mental activity. Hands-on activities are not enough students also must have 'minds-on' experiences." Available at: <http://www.nap.edu/openbook.php?record_id=4962&page=20>. Last accessed 16 February 2012.

26 Oliver Smithies was awarded the 2007 Nobel Prize in Physiology and Medicine for the discovery of homologous recombination. The picture is from the transcript of his lecture for the Nobel Prize (Smithies, 2007). Picture four is available on <http://www.lifetechnologies.com/order/catalog/product/4359659>. Last accessed 12 June 2012. The picture of the OpenPCR are respectively from *Make*'s blog (4), available at: <http://makezine.com/2010/06/24/things-heat-up-for-openpcr-project/> and on <http://pictures.doccheck.com/de/photo/15460/size/m> Last accessed 12 June 2012.

More specifically, by being portrayed in the *Make*, DNA extraction, gel electrophoresis and DNA amplification become part of a socio-technical vision promoting the idea that by becoming personal, our relationship to technologies become meaningful. As yet another set of tools in the hand of the maker, these technologies come to enable an imploded socio-technical vision where the spectacle of grassroots American innovation as the entrepreneurial source of endless economic rejuvenation infuses into biotechnology.

Third snapshot – DIYbiologist also as makers of personal biologies

On the first of May 2008, at the edges of MIT campus, these same experiments reappeared in the first inspiring presentations given by MacKenzie Cowell, DIYbio co-founder, and lately were used as the first hands on activities pursued by DIYbio members. The first off line meeting of DIYbio took place at Asgard's Pub, in Central Square Boston at the margins of MIT's campus. My description draws on two distinct re-transcriptions of the meeting. The first, entitled 'Don't phage me, Bro!' and written by Jason Bobe, was posted a couple of weeks later on the central blog on DIYbio.org. The second was part of the multi-sided ethnography on constructive biologies carried out by Roosth. Both descriptions begun by citing the questions with which co-founder MacKenzie Cowell, in the role of animator, engaged those in attendance:

> Can molecular biology or biotechnology be a hobby? Will advancements in synthetic biology be the tipping point that enables DIYers and garagistas to make meaningful contributions to the biological sciences, outside of traditional institutions? Can DIYbio.org be the Homebrew Computer Club of biology?

These questions sounds like a continuation of the question aimed at figuring out what Do-It-Youself biology is, that the DIYbio co-founder sent out as part of the e-mail announcing the meeting. The kick off meeting was both about inspiring attendees by illustrating that the promise of a biotechnology as a hobby could become a reality, and convincing them that this realistic promise needed their participation in order to become true. These questions also reflect the hope that the boundaries between the creativity deployed in leisure activities and the creativity recognized as a source of technological innovation might, once more, this time in the field of biotechnology, be productively blurred.

A couple of weeks after the first meeting, MacKenzie repeated his advocacy exercise

by giving a very similar (if not identical) presentation at Ignite Boston # 3. Here, I pause to look at MacKenzie's presentation as a persuasive gesture which was part of his effort to gather a 'community.' As briefly mentioned in the first chapter, 'Ignite – Enlighten us, but make it quick,' is a worldwide event which is part of O'Reilly Media Inc. Speakers are invited to present short and engrossing stories about their contribution to the advancement of science and technology. The video of MacKenzie's presentation was posted on his Vimeo account, on the DIYbio website and several other blogs[27]. While his power point slides are being set up MacKenzie begins:

> All right everybody, I was just looking around and I thought I might just check and see with a raise of hands who cares about biology? Who thinks it's cool? [Screams and hands raised in the audience] Yeah! All right! So these are replicating machines, they are neat! Lot of power there!

He moves to his opening slide. On it there is a microscopic image of a viral infection accompanied by the phrase 'Don't phage me bro!' The audience bursts into laughs.

The image was a joke that Jason Morrison, an early member of DIYbio and friend of MacKenzie, posted on the blog LoLScience.[28] His joke was a remix of an 'Internet meme' initiated by the expression 'don't tase me bro!' screamed by a student in journalism at the University of Florida while, having insistently asked senator John Kerry some challenging questions during a public debate, he was immobilized and tased by the campus police.[29] The phrase and videos of the scene quickly became the most cited phrase of 2007.[30] A series of 'remixes' were produced, of which 'Don't phase me, bro!' in reference to the famous pistol in Star Trek, became the most popular.[31]

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27 The video is available at <http://vimeo.com/3454392>, from which it was played 6, 222 times, on <http://www.bostontoursall.com/tag/ignite>, and on <http://cis-action.com>. Pictures of his presentation were uploaded on <http://www.flickr.com/photos/rachelfordjames/2537247081/>. The PowerPoint slides of the presentation were made available on SlideShare, a service similar to Scridb. Available at: <http://www.slideshare.net/IgniteBoston/03-mackenzie-cowell>. Last accessed 27 February 2013.

28 In an online article of the Newscientist, LoLScience (LoL is an Internet culture shortening for Lot of Laughs) is presented as an 'extension' of LoLCats, 'an Internet meme/fashion that consisted in spreading images of cats in bizarre situations and commented on by phrases that were 'laced with diabolically bad grammar.' Available at: http://www.newscientist.com/blog/shortsharpscience/2007/12/lolscience.html. Last accessed 29 October 2012.

29 Morrison image was introduced by the phrase 'imma chargin mah mRNA!' another remix from a famous phrase http://lolscience.livejournal.com/25744.html#comments. Last accessed 29 October 2012.

30 Available at: <http://www.washingtonpost.com/wp-dyn/content/article/2007/09/18/AR2007091802115.html>. Last accessed 27 October 2012.

31 Available at: <http://knowyourmeme.com/memes/dont-tase-me-bro>. Last accessed 27 October 2012.

This very same story eventually inspired Morrison's biology version: 'Don't phage me, bro!'

Figure 3.6 Humour as remix.

Don't Tase Me Bro! (2007) Don't Phase Me Bro! (2007) Don't Phage me, Bro! (2008)

From a troubling example of campus' police violence in the USA, to a first cultural abstraction, to a second cultural encapsulation.

I pause on this example to illustrate how the metaphorical trafficking between computers and biologies is not only about technical analogies, but also, as Roosth observes, 'about analogized practice and socialities' (Roosth, 2010: 110). 'Don't phase me bro' as an expression of mainstream geek humour, is turned in to bio-geek humour, not yet mainstream. Furthermore, remixing, a practice that can be highly concerned and extremely reflexive about the origins of each of the assimilated elements (Baldwin, 2011), becomes in this case a gesture where the result erases the original. Here, a politically charged expression is assimilated, and erased, as part of a type of humour that mobilizes elements of science fiction and technical or science-oriented themes. That is not to say that biologists do not have a specific humour tailored to their professional experience, but rather that the members of the DIYbio network in their effort to establish a new tech culture in biology have developed their own 'bio-tech humor,' a type of humour on biological matters that both mobilizes reference to tech culture and life sciences themes, and, at least in this case, cares little to engage with the politics of the original expression. Having captured the audience's attention, MacKenzie begins by presenting DIYbio as a 'little start-up community' and continues:

> so 'don't phage me bro,' is what this image says, and I like it a lot because it sort of sums the ethos in this group which is just starting, and one sort of technical literacy but in a positive way and in a fun way so what we are trying to do, is

> basically being the 'Homebrew Computer Club' of Biology today and this got started thirty years ago and helped musher in the computer revolution.

MacKenzie moved onto asking why DIYbio did not emerge in parallel to the computer revolution and suggested the reason was that 'because actually, genetic engineering was not actually genetic engineering, genetic engineering is actually starting today under the guidance of a new field called synthetic biology.' MacKenzie presented synthetic biology as 'paving the way forward' for a DIY community to thrive, but concluded by questioning whether there is actually a DIYbio community out there. The doubts that MacKenzie raised in his question were nevertheless swiftly answered by himself, using persuasive examples. MacKenzie proposed that, similarly to TechShops, DIYbio should focus on establishing LabShops. 'TechShop – Build Your Dreams Here,'[32] are a chain of membership-based workshops that provide their members with access to a variety of tools for rapid prototyping. The first TechShop opened in 2006 in Melno Park, California, out of frustrations very similar to those that echo in Dougherty and *Make.*[33] In an interview for a local newspaper, Ridge McGhee, TechShop co-founder, exclaimed: 'We're very upset that we're giving away manufacturing ability, development ability, to other countries […] We want to give people the capability to develop here.'[34] On the TechShop website the place is described as:

> perfect for inventors, makers, hackers, tinkerers, roboteers, families, entrepreneurs, youth groups, FIRST robotic teams, arts and crafts enthusiasts, and anyone else who wants to be able to make things that they dream up but don't have the tools, space or skills.

MacKenzie, who discovered TechShop shortly before he started DIYbio, remixed its name. TechShops become LabShops, imagined as a place where anyone could offer and take classes in molecular biology. After having presented the idea of LabShops, MacKenzie raises doubts again, asking the audience if there is really someone who is interested in joining such places. While showing the last picture of a TechShop's interior, he asked the audience to focus their attention on a magazine which had been left on the table of the TechShop. The headline is readable by the audience: *Make* Issue

32 Available at: <http://www.techshop.ws/index.html>. Last accessed 30 October 2012.

33 TechShop is advertised on the *Make* website and projects from TechShop's users are often reported on the website and in the magazine.

34 Available at: <http://www.almanacnews.com/story.php?story_id=2743 31.10.2012>. Last accessed 30 October 2012.

7 'Backyard Biology.' MacKenzie then quickly flipped through his slides, as if he were browsing the pages of the magazine:

> let's hack biology right - next slide - [showing the cover of the Making magazine volume 7 and different projects] – let's do DNA extraction in your kitchen [showing Dr. Shawn DNA extraction] - next slide - let's make a PCR thermocycler it will cost 200$ [showing the McGuyver project] - next slide - three months later someone published how to do it for $10. People like this and they are starting to hack it, so DIYbio, we are getting started, it's really cool!

Finally, he concluded his ten minutes of biotechnology storytelling by consolidating his narration:

> So what are our goals? Monthly meet-ups and starting the TechLab in the next six to twelve months so stay tuned for that [loud shouting from the audience] so visit DIYbio.org and remember real hackers write DNA!

This first example illustrates that, offline, the DIYbio network started as a specific type of storytelling – a short and fast-paced power point presentation packed with illustrative images, humour and interactive questions for the audience. This is a story telling whose persuasive strength – to convince the members of the audience that DIYbio is the 'next big thing' – is based on a diverse number of analogies with existing initiatives, and which is preoccupied with the rejuvenation of national economies and the search for a meaningful relation to technology. MacKenzie proceeded by posing a series of rhetorical doubts to which existing initiatives that were related to the maker movement were able to provide systematic answers.

In the two following months, the second and third meetings of the newly formed DIYbio network were held in Boston at the Betahouse, a 'co-working space for entrepreneurs, technologists and creative.'[35] This time, both meetings were advertised as 'hands-on.' During the second meeting, members replicated the DNA extraction from the article 'The Kitchen Counter DNA Lab,' while on the third meeting they replicated the first part of the experiment proposed in the 'Home Molecular Genetics' article (Roosth, 2010: 133). When the first journalists described members of DIYbio performing these experiments, the fact that they were replicated from *Make* Issue 7, 'Backyard Biology,' and that they were initially designed by professional scientists and science educators, were not mentioned. Instead, what was portrayed in the article entitled 'Rise of the garage genome hackers' was the excitement for a 'movement that

35 See Chapter Two.

hopes to spark a revolution in biotechnology' (McKenna, 2009).

Figure 3.7 Taking pictures.

The picture taken by MacKenzie during the second meeting in Boston. On the right: the anthropologist Sophia Roosth. The image, uploaded onto the Flikr account of MacKenzie, was used by Phil McKenna in his article entitled 'Rise of the garage genome hackers' McKenna (2009). The blue frame indicates the way in which the picture was re-framed when published.

As new members joined the DIYbio network, the majority of them progressively networked themselves to the MAKE. The first stall maintained by a member of DIYbio was held at the 2009 Bay Area Maker Faire edition, entitled Re-Make America. In a conversation, Tito Jankowski, a founding member of the regional DIYbio group, recalled the event by mentioning with excitement that he ended up supervising hundreds of DNA extractions from visitors' saliva. Ten months later the second European Maker Faire was held at Life - Science's Centre during the Newcastle Science Fest. This was the first occasion for two founders of the Europe-based DIYbio network to physically meet at a co-hosted stall. Brian Degger, a self-described 'scientist, part-time cryptozoologist, interdisciplinary researcher, and artist' (Degger, 2007) constructed a DIY magnetic spinner at the table. Cathal Garvey, a drop-out Ph.D. student in genetics, was prevented by airline policies from bringing his bioluminescent bacteria over. He therefore could only showcase the protocols for their isolation from squids and the rotor of his first invention: the Dremelfuge[36]. Their

36 Garvey designed a rotor with open source software CAD, printed it in 3D with his Makebot, screwed it to the spinning head of his Dremelfuge and used is as a centrifuge (see Chapter Five).

débutante proposition nonetheless captured the attention of a journalist from the British Broadcasting Corporation (BBC), who filmed Garvey performing a DNA extraction from kiwifruit with household reagents, and uploaded the video onto the BBC's website (Ward, 2011). In December of the same year, Garvey's Dremelfuge was also featured in the blog of *Make,* in a post from the Associate Editor, Becky Stern.

In May 2010, DIYbiologists in the Bay Area held two stalls at the San Mateo Maker Faire. Jankowski was in the company of Josh Perfetto, a software engineer and autodidact biotechnologist with whom he co-founded OpenPCR. As part of a workshop entitled 'Hate Brussels Sprouts? Blame your genes!' based on a Singular Nucleotide Polymorphism (SNP) genotyping experiment, they showcased the Open Gel Box 2.0[37] and the OpenPCR - Open Source, hackable PCR machine - that they had designed.[38] Although they had only presented the first prototype, more than ten visitors signed up for pre-orders. They intercepted visitors, asking 'Hate Brussels sprouts?' and offered experience of genotyping 'the responsible gene.' In a video recorded at the stand (and uploaded onto YouTube), Jankowski explained how both the Open Gel Box and the OpenPCR could be used to 'look at our own DNA and figure out what our DNA says about that bitter taste capability.' After showcasing the tools and the process, Jankowski attempted to persuade the viewer that:

> It’s really a simple analysis; either you do or you don't and we can show you all the techniques and the cool things. You don't have just to look at the bitter-tasting gene, you can take this technique and look at anything in your DNA. This is one letter out of three billion letters in your genetic code there are three billions of other things that you can do!

Jankowski promoted DIY genomics as the ultimate antidote to boredom, and suggests that hands-on interaction with one’s own genome is as much about a relationship between genes and health as it is a recreational activity promising fun and entertainment. In Jankowski's proposition, the rhetoric of the endless possibilities of genomics establishes an additional entertainment value that is presented as accessible to everyone.

At a stall nearby, Eri Gentry and Joseph Jackson, both co-founders with Jankowski of Biocurious – the Bay Area biology collaborative lab space – distributed leaflets

37 The Open Gel Box is an open source hardware used to 'run' agar gels.

38 The OpenPCR is an open source hardware used to produce the poly chain reaction (PCR), a chemical reaction used to duplicate samples of DNA.

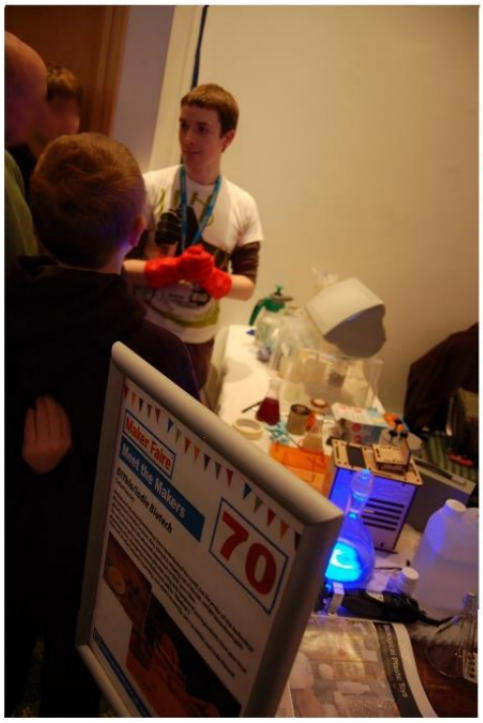
presenting the project at its early stage and advertised membership deals.

In the autumn of the same year, three founding members of the New York DIYbio network (soon to become Genspace – New York City's Community Biolab) participated in the World Maker Faire, held at the New York Hall of Science. While there, Daniel Grushkin, Ellen Jorgensen and Russell Durrett, a third co-founder of the regional group, invited visitors to join their 'DNA extraction Party.′ About his participation, Grushkin recounts: 'I remember how amazing it felt to join this group of makers. A home coming of sorts.' An account of this activity was published by Gentry on MAKE Blog[39], where she and Jankowski had been invited as Citizen Science Guest Authors (Gentry, 2010). In 2010 members of the DIYbio network participated at least in five different Maker Faires, respectively in Newcastle, San Mateo - Bay Area, New York, Brighton and Cairo.

Because Garvey left 2010's Newcastle Maker Faire with the impression that he did not show much, he mentioned: 'next Maker Faire I said no! Let's do this properly – and the next year we had a load of stuff on the table.' I first met Garvay wearing a thick pair of red rubber gloves and a t-shirt with the logo of DIYbio. At the table, Garvey displayed the essential elements of his own home made laboratory (see next chapter). For instance, under his portable sterile homemade laminar flow cabinet, participants were invited to inoculate homemade potato starch media with a culture of *Bacillus subtilis* and to bring it home. He produced the sterile hood by partially following the instructions on Make's Issue 'Backyard Biology.'

Figure 3.8 DIYbio members at the Maker Faire in New Castle.

39 Since September 2010, Gentry and Jankowski have been regularly invited to post on MAKE blog as Citizen Science Guest Authors (Branwyn, 2010).



On the right: Garvey at New Castle's Maker Faire. On the left: the phrases that Garvey wrote on the back of his business card. They read: 'Hair colour that changes hourly? Glowing Seamonkies to Light the Third World? Plaque that repairs teeth? House plants that smell cancer? Tattoos that shine when you smile? Seeds that grow houses? Autumn streets lit by glowing pine cones? And Painting with living pigments?'

While Garvey recalled his favourite moments from the latest Maker Faire, he explained:

> Where the message of DIYbio, which is probably the wrong message to say 'you can do science too!,' I think a better message is what make scene is doing as a start, to not even mention the word science: let's do DNA extraction, let's sequence your DNA, let's hack that bacteria, let's program that petunia, it is not science it’s hacking, it’s making, it’s playing, it’s fun.

From his participation in what he calls 'the maker scene,' Garvey realizes that by removing the word 'science' and stereotypical representations of science such as the lab coat, he could allow visitors to experience science, in his case microbiology and genetics, as common, normal and belonging to the familiar space of the home.

At the 2011 San Mateo Maker Faire, entitled 'Take the world in your hand,' the DIYbio presence and proposition again grew larger and more sophisticated. Jankowski and Perfetto presented their progress on the almost-ready-to-ship OpenPCR, and they advertised their first social outreach project. The '7 Days 7 Schools Initiative' aimed at

raising money to deliver seven OpenPCR machines to schools around the world that could not afford the cost of a professional thermo cycler. At the adjacent stall, five funding members of Biocurious, proposed to observe different slides under the microscope and to test the production of electricity from Winogradsky columns.[40] Visitors could win free classes at BioCurious by taking a picture in an empty hole of the BioCurious Mad Scientist Hall of Fame. The motivations of Gentry, one of BioCurious co-founders, were pragmatic: 'I was told Maker Faire was a good way to expose many people to Biocurious. Since it was important to get support, I went.' At the end of the day, Biocurious was given the Maker Faire Education Award (Brokelynn, 2011).

Figure 3.9 DIYbio members at the Maker Faire in San Mateo.

In clockwise order from the left. The table of Biocurious at the 2011 edition of San Mateo Maker Faire. Gentry interviewed by the in-house journalist crew of *Make.* A journalist asks Jankowski and Perfetto to pose with their OpenPCR, and I was present to take a picture of them being pictured.

Finally, a month later, GenSpace's members were invited to Maker Faire Cairo. While they were there, Ellen Jorgensen, Oliver Medvedik and Sung won Lim (all of whom

40 Winogradksy columns are a cylindrical device used to cultivate a diverse biotope of micro-organisms. The growth produces several gradients of chemicals, some of which can be used for the production of weak electric currents.

are GenSpace's co-founders) proposed two three-hour-long workshops and a talk. Participants could practice personal genotyping using SNP sequences and build their own laboratory equipment. During the talk won Lim, an undergraduate student in physics, presented his preliminary work on software aimed at facilitating the downloading and use of sequences from the BioBrick registry.[41] won Lim recalled that 'Genspace participation in Maker Faire was a great idea. I felt like we really belonged there.' Medvedik, speaking about his relation to the maker movement, mentioned:

> I wish I was a maker, I wish I had my workshop outside Genspace, I wish I was tinkering out more, building my own car – it is ingrained in American culture, and I appreciate the movement. That whole core principle of self-sufficiency – it is a very protestant American core principle and in that sense I think it is immensely positive.

By participating in Maker Faires, DIYbio members have access to a number of immediate benefits: co-hosting stalls is an important opportunity for DIYbio members to physically meet; and their repeated participation is a chance to improve their skills as communicators, as well as to develop new persuasive and participatory public demonstrations that a Do-It-Yourself biology is possible. The Faires also provide a large and enthusiast audience who can be exposed to DIYbio initiatives, an audience whose members might become active in community laboratories or support the network's activities by purchasing laboratory instruments sold by its members. The maker movement also consolidates DIYbio members' credibility by inviting them to be guest bloggers, or by giving out awards for their demonstrations. But, as becomes apparent in the answers of the DIYbio members, the Maker Faire and the figure of the maker also offer an additional and fundamental service: both offer hospitality to the uncertain and mostly still transient activities of DIYbio members. The feeling of belonging is expressed explicitly by endorsing the maker's socio-technical vision, or implicitly using phrases such as 'home coming,' to describe participation at a Faire. At the same time, by using the experiments demonstrated in the Backyard Biology issue, and by joining Maker Faires as a hospitable forum of manufacturing, DIYbio members can become active makers of biology as a personal technology.

41 The registry of standard biological parts was developed by students and researchers in the field of synthetic biology. The aim of the registry is to provide an online and physical archive of genetic constructions that are freely shareable and usable by all the participants of the iGEM (Registry of Standard Biological Parts, n.d). For an ethnography of iGEM see Aguiton (2012).

Conclusion

In this chapter, I began by arguing that in order attain a deeper understanding of what DIYbio is, a detour from a narration of its emergence as a ramification of synthetic biology, and as an online community, is necessary. Peeping at the DIYbio network through the kaleidoscopic figure of 'the maker' is an attempt to narrate its formation as a more swarming and seething semiotic-material assemblage: The MAKE. In particular, to situate the maker as a figure to be embodied, in the first snapshot I followed three central actors:, Tim O'Reilly, CEO of O'Reilly Media Inc. and publisher of *Make*; Dale Dougherty, *Make'*s Editor and Publisher; and Mark Frauenfelder, *Make*'s Editor-in-Chief. I argue that in their role as network entrepreneurs they successfully combined the legacy of the Whole Earth Catalog, the spectacle of the grassroots American innovation as an endless source of economic rejuvenation, and the members of a digital generation in search of unplugged socialities. I concluded that in doing so, MAKE becomes a curatorial practice aimed at organizing makers' communications and gatherings as a natural and national resource of innovation – a source of innovation that the maker embraces by transforming his or her house into an innovation and business incubator.

In the second snapshot, I traced the assimilation of biology and biotechnology into the maker movement. By looking at the *Make*'s Issue 'Backyard Biology,' I traced how biology and biotechnology are represented and made into yet another small-scale and personal technology in the hands of the maker. I argue that as biology and biotechnology are brought into the home of the maker, the home as a business incubator can be further understood through the figure of the breeding reactor – a place where the making of cyborgs becomes a personal and familiar activity. Rather then being an endeavour in the hands of scientists, cyborg making becomes an activity available to all, or at least to all the makers. An activity presented as personally empowering as well as intimately tied to the myth of American grassroots innovation. I then paused on two particular activities portrayed in the pages of the Issue Backyard Biology: a demonstration of how to extract DNA, and a demonstration of how to build a PCR machine with the aim of genotyping some of the DNA. The demonstrations were proposed by an ex-physicist who, committed to changing institutional science, turned into an advocate for amateur science as a place where truthfully creative work could still be done. But also by the members of a research unit specialized in science

education programs. Taking the example of the PCR, I proposed that, in a sense, the technique has metaphorically completed a full amplification cycle – one characterized by the recursive replication of the experience of prototyping the machine itself. From the prototypes assembled in state-of-the-art laboratories of the 1980s, to the prototype presented in *Make*, to the OpenPCR proposed by DIYbio members, the building and use of a PCR machine becomes another tool in the hand of the maker. Together with DNA extraction and gel eletrophoresis, the PCR become another personal technology.

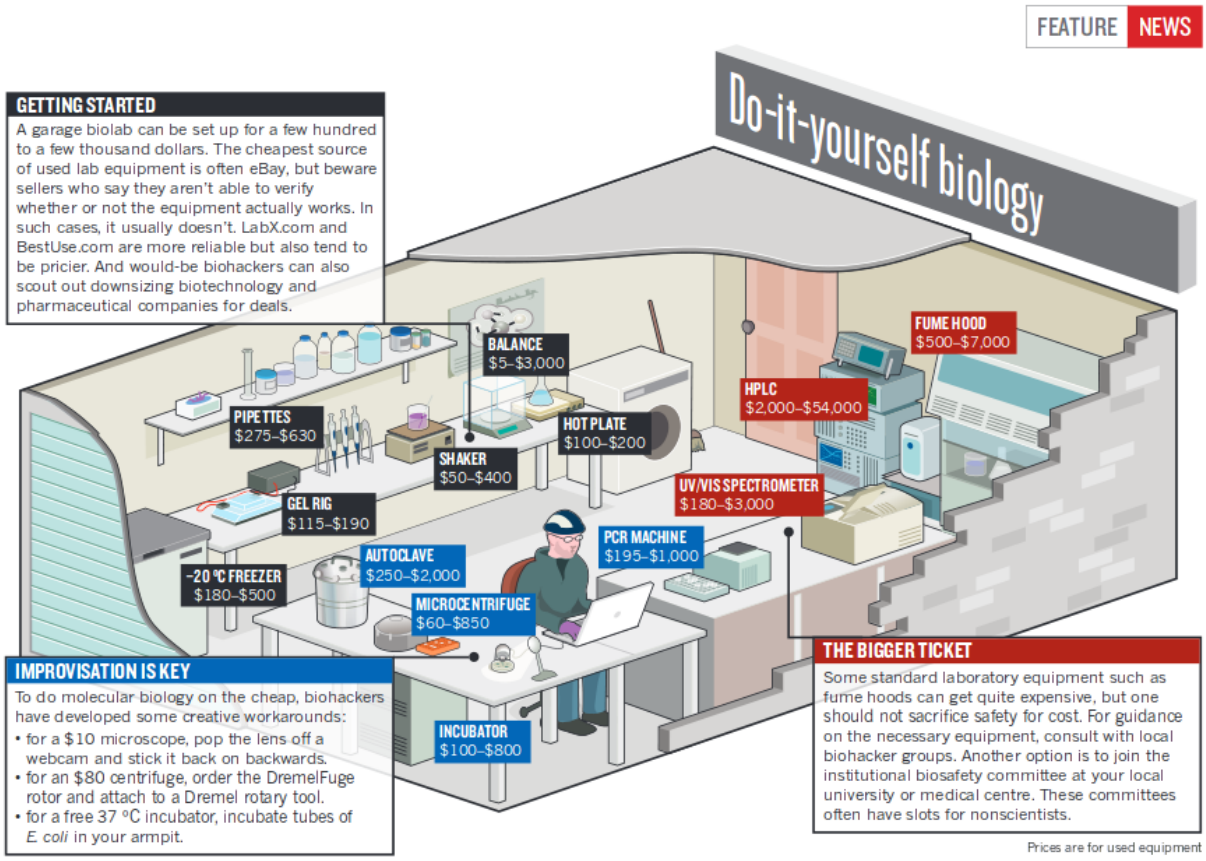
In the third and final snapshot I followed the projects of *Make*'s Issue 'Backyard biology' as they become first the examples, and then the demonstrations, of the possibility of a Do-It-Yourself biology. By analysing transcripts of the first DIYbio meeting, and the video of one of the first public presentations given by MacKenzie Cowell, I argued that the rhetorical doubts that, he punctuates his 'enlightening' presentation with are repeatedly resolved by using examples from the maker movements as analogies or demonstrations. I concluded the snapshot by illustrating how, as new members joined the DIYbio network, a majority of them networked themselves to the MAKE. In particular, I argued that the MAKE provided hospitality and a numbers of important opportunities for DIYbio members to meet offline, to improve their skills as communicators, and to develop a new and persuasive demonstration that a Do-It-Yourself biology is possible. As such, I argued the DIYbio network became another point of circulation and elaboration of the imploded values of the MAKE, and in particular it became one of a personal biology and biotechnology.

By unpacking the *Do*, the *It* and the *Yourself* in DIYbio as it gets defined, Roosth's work describes DIYbio as an example of 'constructive biologies.' In her work, the specificity of the *Do* refers to an amateur gesture of 'making do' as opposed to other observation-driven amateur activities (e.g. ornithology, botany), and to the *un*disciplined and bricolage biologies as opposed to the professionally disciplined one approach of synthetic biology (Roosth, 2010: 112). The *It* is the biological, which for biohackers is 'life' as it gets made as much as it is biological things that are hackable and shareable as Open Source software (2010: 123). Simultaneously, *Yourself* refers to 'a means of fashioning themselves as both biological subject and political actors' (ibid.: 138).

Another way of understanding 'do-it-yourself' would be *MAKE-it-personal*, where the MAKE is the specific culture of making as embodied in the figure of the

maker. *It,* is additionally intended as life as a small-scale technology in the entrepreneurial hands of the maker. Finally, *personal*, while still about both biological subjects and political actors, is relevant specifically in the context of a reassembled counter-cultural and entrepreneurial legacy. The 'personal' that I use to coin the term 'personal biologies' is the re-surging of 'personal' as in personal computers, and it refers to the belief that biology should be practised by everybody, but more importantly that a small-scale and socially meaningful biology and biotechnology can only be produced by the people.

4. The hobby of turning biotropes into bioworlds



An illustration of Robert Carlson' s home laboratory published in 'Garage biotech: Life hackers,' Nature online, October 2010.

Introduction

This chapter opens with a representation of a home laboratory published on the online portal of Nature, a prominent scientific paper. The author tells us the story of Robert Carlson Ph.D., a physicist turned techno-visionary, consultant and garage biologist. In the article, Carlson positioned as a 'biohacker,' and an inspiring figure for the members of the DIYbio network, is described as having spent five years and several thousand dollars trying to demonstrate that garage biology is an empirical reality. The opinion of the commentators oscillates. A critic, the anthropologist Christopher Kelty, claims that the field is 'over-hyped,' that no one needs a PCR machine at home, and that while research prices are falling, overall biological research remains expensive. An advocate, George Church, the founder of the Personal Genome Project at Harvard University (and the employer of Jason Bobe, DIYbio co-founder), answers that, back in the day, the same things were said about personal computers. The author concludes that,

despite Carlson having obtained few results, he still believes that 'part of the exercise was to determine whether or not we could bootstrap this thing [garage biology].' Therefore, for Carlson "the answer appears to be 'yes.'" As long as you are willing to be patient and to eat nothing but rice for dinner occasionally' (Ledford, 2010: 652). If Carlson was 'not patient' and has since focused on his business as a consultant among the members of the DIYbio network, his example of an home-made laboratory is still inspirational.

In the first chapter, I proposed that social media, as a technology of realization was instrumental for the figuring out of the very meaning of a do-it-yourself biology. I argued that in the uncertainty of establishing their socio-technical project, DIYbio members found in social media, and particularly in blogs, places for collectively elaborating their identities, and tools for immortalizing and disseminating their socio-technical vision of a biotechnology available to all. Moving offline, the second chapter proposed to diffract once more the story of DIYbio's origins, this time by tracing their initial DIYbio practices as part of a larger curatorial project: The MAKE. By tracing the assimilation of biology and biotechnology to the maker movement, I argued that these practices become yet another 'set of tools' in the hands of the maker, and therefore a spokes-technology for a socio-technical vision rooted in the legacy of the *Whole Earth Catalog*, the spectacle of grassroots American innovation as an endless source of economical rejuvenation, and a digital generation in search of carefully negotiated, unplugged socialities. As one of the key aims of this thesis is to question how a reconfigured version of digital utopianism is informing an emerging socio-technical vision and practice of biology and biotechnology as a personal technology, this chapter further looks at how the socio-technical vision of a personal biology was actually made into a practice.

As for the opinions of sceptics and advocates presented in Nature Online, scholars' interpretations of DIYbio practices tend to be expressed in the form of a dichotomy. Some authors consider such practices as unique and significant; others criticize them by exposing the limits of their participatory promise; many oscillate between both interpretations. For instance Roosth's early account concludes by stating that 'DIY biology does not reformat or significantly impact the biosciences, and I doubt it ever will' (Roosth, 2010: 145). Nonetheless, she argues that by displacing the engineering ideal of biology into domestic spaces, 'authority, subjectivity and practice'

are re-configured (Roosth, 2010: 145). Similarly, Delfanti writes about 'very elementary scientific practices,' indicating that 'in most cases the media attention overstates and mythologizes very poor scientific practice' (Delfanti, 2011: 110). Yet, in his conclusive remarks he writes: 'with its radical request for openness and its rejection of institutional prerogative and constraints, garage biology surely challenges many assumption about public participation in scientific knowledge production' (Delfanti, 2011: 121). In what could be read as a partial answer to Roosth and Delfanti, Delgago argues that while DIYbio practices are often trivial and domestic, to argue that DIYbio is not a site for technological innovation is problematic: if 'DIYbio does not necessarily pursue the kind of science and innovation that occurs in institutional settings. […] DIYbio [nonetheless] entails a different way of engaging with science and technology, and with the making of things and futures. It is biology moving out of institutions and to the realms of the public.' (Delgado, 2013: 66). Lastly, more modest contributions, such as the one from Winston, limit themselves to noticing the difference between the stories about biohackers and the reality of field work, where, as Winston expresses it, he could rarely witness the success of an experiment (Winston, 2012a: 34).

If part of this ambiguity might be related to the early deployment of scholars in the field, during my field work I came to experience such ambiguity also as related to what I came to call the transience of DIYbio practices themselves. In the methodology section, I briefly presented this notion as an attempt to engage with a practice in-the-making, where public demonstrations are temporary, and home and community laboratories would form, cease to exist, or eventually re-form. Following on that commitment, my aim for this chapter, is to take this transience seriously - both as a methodological commitment, and as a constitutive element of DIYbio practices. The argument at the core of this chapter is that, as the socio-technical vision established by DIYbio co-founders addressed, among others, young and/or disenfranchised scientists in their attempt to develop a different practice of biology and biotechnology, the transience of their practices reveals their often precarious financial or professional condition, but also the uncertainty of their epistemological and empirical proposition. My argument develops along a detailed description of one home laboratory, the one of Cathal Garvey, a prominent and respected DIYbio member based in Cork. His case is of particular relevance because, as with Carlson, he tried for several years to turn his

critique of mainstream technoscience into a practice he could live by and with. As I follow him while he describes his home laboratory to me, I question what it means to enact a certain critique of technoscience in the form of an empirical practice. My point is not that Garvey's example is representative of the DIYbio network, a group whose vitality is dependent on being capable of assimilating a great diversity of practices and opinions. Instead, Garvey's example, as one of the several disenfranchised scientists addressed by the DYIBio socio-technical vision, enables me to reflect upon what it might mean, as a young white scientist, to turn one's own critique into an empirical practice, and to live of it.

The first snapshot portrays Garvey as he attempts to problematizes the political economy of contemporary biotechnology, in particular his dissenting attitude towards a technoscience increasingly poisoned by monetary interests. I read Garvey's dissenting voice in the light of Kerry Holden's work on the institutional formation of scientific careers under the changing political economy of technoscience (Holden, 2010). If Holden proposes that her interviewees yearned for a 'Golden Age' of public and fundamental research untouched by audit and managerial practices, as a myth that gets them to 'do the job' (Holden, 2010: 224) Garvey dropped out in an attempt to turn his political critique of contemporary science in to an empirical practice.

In the the second snapshot I follow Garvey's description of his laboratory, tracing the demonstrative effort of turning his political critique of biotechnology into an empirical practice. By partially maintaining the structure of the lab tour, my aim is to discursively reproduce the effect of being told how to set up a laboratory on a shoestring, and for the reader to thus evaluate what type of laboratory we actually end up with. I argue that Garvey's descriptions are marked by his attempt to produce equipment and procedures that, as he names them, are affordable, available and achievable. He does that by finding 'creative substitutions,' another term that he use to define his own practice. As I follow him, I notice that when he moves from explaining how to build an instrument from how to use it, or when he gives further details on a procedure, his descriptions thicken. The simplicity of his initial descriptions belies the complexity and the depth of his knowledge, but also reveals a number of unexpected problems in his experimental practice. In this sense, I argue that the establishment of the laboratory is an experiment in itself, one that, after all, is not as straightforward as it seems at first sight.

Once the laboratory is set up, in the third snapshot I describe the most ambitious experiment carried out by Garvey, the creation of an IndieBB plasmid, as the backbone of an open-source biology. This example allows me to pursue my interest in understanding how Garvey's attempted to turn his political critique into an empirical practice. My interest does not lie in knowing if Garvey is successful or not. What I am interested in is how his attempts to stabilize his practice reveals the deep entanglement between his commitment to a biotechnology for the people as an antidote to the imperative of commercial values in technoscience, and the uncertainty of his financial conditions, as well as his epistemological and empirical practices. In the conclusion, I return to the themes addressed in the chapter and frame them using Latour's works on Pasteur, and his analysis of laboratories as political instruments (1983).

First snapshot – Enabling an holistic biotechnology for the people

On May 2011, I travelled to Cork Ireland to visit Garvey and his home laboratory. Cork and Cork County are one of the major industrial centres of Ireland, and their economical rejuvenation benefited from what is commonly called the 'Celtic Tiger'[1]. Industrial sectors settled in the region include chemistry, brewing, distilling, food processing and pharmaceuticals, but also electronics manufacturing and electronic commerce companies. Moreover, very recently, Cork has also been designated as yet another 'next Silicon Valley of biotechnology,' with significant venture capital investments targeting 'indie tech culture' (Connolly, 2014).[2]

Garvey lives in Cork, but when the flats he shares with his wife became too small to both host his family and his laboratory, he accepted his mother's offer and moved the latter into an empty guestroom at his parent’s house, located a fifteen-minute car ride from the city centre. As we rode, the small city of Cork quickly melted into the countryside where the houses become fewer but grander. Waiting for the entrance gate to open, Garvey explained with amusement that it was built to prevent

1 The period spanning from 1995 to 2000, is mostly understood as a result of reforms in stated economic development, long term investment in domestic higher education, reduction in corporate taxes, improved stability of the North-South divide, and successful leadership during the Irish presidency of the European Union (Peet, 2004).

2 The term 'indie' is a short form of 'independent' that was adopted in reponse to the resurgence of an independent pop music scene in the late nineties, and that is since widely used in a variety of sectors including fashion, food and art.

the free ranging chickens from escaping. Inside the house, the bright and spacious hall was welcoming. Indicating the way, Garvey opened a second gate, this time a child safety one, and guided me down to the ground floor where the laboratory is located. From the laboratory's windows my gaze rolled down through the gentle slope of the lawn, passed the vegetable garden, the tennis yard and leaped into the open and green rural Irish landscape.

Figure 4.1 In the Irish countryside.

From left to right, an image of Garvey's laboratory from outside and a view of the house from the tennis yard. Both are two print screen from the web-documentary 'Biohackers: les Bricoleurs d'ADN'[3].

Garvey is one of the earliest and since most active members of the DIYbio network and at the time of the interview he was twenty five. He graduated with a Bachelor Degree in Genetics from University College Cork but, as he had recently dropped out from a Ph.D. program at the Cork Cancer Research Centre, he was temporarily unemployed. On his publicly available LinkedIn account he described himself as 'Biohacker-in-Chief at Glowbiotics Ltd.'[4] a company he incorporated in 2012. While on Twitter, the tags defining his profile are: 'Synthetic Biologist, Geneticist, DIY-synbio Enabler, Crypto-enthusiast, Vegetarian, @sciencegallery Leonardo, Loving

3 The documentary is available on the website of Le Monde at: <http://www.lemonde.fr/technologies/visuel/2013/07/07/biohackers-les-bricoleurs-d-adn_3441946_651865.html. Last accessed 12 July 2013.

4 'Glowbiotics is a mission to create and disseminate patent-free, Free/Libre tools for Synthetic Biology, designed to require less effort, time or thought. Glowbiotics tools are intended to be foundations for more advanced projects and technologies, and to enable others who might otherwise be resource, skill or time limited to advance in the rapidly changing sector of Synthetic Biology.' Available at: <http://ie.linkedin.com/pub/cathal-garvey/92/771/830>. Last accessed 29 April 2014.

Husband & Dad.'[5] As with other DIYbio members, Garvey posts regular and descriptive updates on his personal blog, uploads videos of his presentations (such as the one he gave in 2013 at TEDxDublin, entitled 'Bringing biotechnology into the home')[6] or public demonstrations on Vimeo and Youtube, and is very active on several online communities and DIYbio mailing lists. During our interview I asked Garvey how he got involved with the DIYbio network. He answered by going back to his teenage passion for biotechnology:

> So my initial thing, that biotech was this amazing thing I should get into early, I then went on to realize that before we were building houses we were building new species and my whole view became much more holistic. But I have always wanted to basically genetically engineer things, when I was young it was for mostly frivolous reason and I still love that frivolous love of just 'wouldn't it be cool if...' nowadays I see it as a way of supplanting oil as the foundation of our society, a self propagation means of harvesting the power of the sun, of cleaning up our mistakes, of feeding the world, of curing diseases without relying on centralized, globalized infrastructure or money of the benefactor, or the rich, real ways to fix the world, I see biotech as one of the avenue that we have to pursue to fix the world.

Garvey's answers indicated that for him artificial selection and genetic engineering are part of a unifying narrative of 'building species.' If this is a rather common way of narrating the story of biotechnology, in the case of Garvey, such a narrative enables him to understand biotechnology as more holistic. This term, used in a multitude of contexts to indicate that the property of an object or a phenomena cannot be reduce to one of its components, but instead needs to be understood as part of a complex, dynamic and interrelated whole, is used by Garvey to talk about his understanding of what biotechnology is. The use of the term suggests that by being holistic, biotechnology and in particular genetic engineering are not a separated or disruptive practice, but are a gradual continuation of farming technologies, therefore a set of practices part of a much bigger whole. Furthermore, in describing his relationship to biotechnology, Garvey also pauses to remember his shift from a youthful attitude, toward a vision of a responsible use of biotechnology intended as a way of 'cleaning up [of] our mistakes.' If the discourse of the technological fix has been widely

5 Available at: <https://twitter.com/onetruecathal>. Last accessed 29 April 2014.
6 Available at: <https://www.youtube.com/watch?v=g_ZswrLFSdo>. Last accessed 29 April 2014.

commented in scholarly literature,[7] in the case of Garvey, for biotechnology to function as a technological fix it needs to be independent from centralized, globalized infrastructure depending on benefactor money. Garvey further explained his political theory of a different biotechnology:

> Coming back to the original question, even if this as a mindset was evolving in my mind I have gone on to work in a cancer research lab. It was really a good experience for me to work in that lab and I don't regret working there, it thought me a lot about how institutional science is conduced and I kind of gradually and increasingly came to see that institutional science it's institutionalized and it's stuck in a sort of a pattern of science that's fantastic for some form of learning, for uncovering fact at some level or in some areas institutional science it's an amazing machine, but for solving world problems it's not because even in publicly funded labs there has to be some private elements. Like institutions value themselves on how much intellectual property they have, it's expensive to get it and then they try to market it which means it has to be a market for it, it's kind of poisonous that they try to find some commercial value in something that might have more...practical value and...I mean don't even get me started on industry, industry will only ever do things that makes the money [...] I was kind of...in cancer research I was seeing that there were amazing approaches to cure cancer that were un-patentable so nobody was interested in following them and I just realized, nothing is going to happen unless people can do it, nothing of this is never going to reach humanity until humanity are doing it.

In the passage Garvey laments that both public and privately funded research is ill-fitted to solve the contemporary world's problems. By doing so he suggests that the problem is institutionalized technoscientific expertise and not, as some critics propose, techno-scientific expertise *per se.* Garvey's words suggest that institutionalization does something recognizable and specific to techno-scientific expertise. Garvey proposes that both private and public research are poisoned by commercial interests and therefore incapable of providing credible solutions to world's problem, and that unless 'people can do it,' nothing is going to change. This last passage is also marked by Garvey's invocation of 'the people' or the 'everyone,' a term used by other DIYbio members, as a force of socio-technical change. In his attempt to understand the

7 See for instance Jeff Douthwaite's critique of a technological fix as a 'an attempt to answer a social or human problem using technological de- vices or systems without any attempt modify to or alter the underlying social or human problem' (Douthwaite, 1983: 31) For a more recent anthropological interpretation see Linda L. Layne's work (2000).

political economy of contemporary biotechnoscience, Garvey proposes that it is only when biotechnology it is putted in the hand of the people that it will produce benefits for humanity. Such biotechnology will not be centralized, globalized and dependent on the money of benefactors. Instead, it will be a biotechnology that is decentralized, local, and dependent on the money of 'the people.' Read in conjunction with Garvey's narrative of biotechnology as holistic, and his use of the terms mistake to understand the consequences of techno-scientific progress, the invocation of 'the people,' especially used as a synonym of 'humanity,' appears as a second, fundamental element of Garvey's political theory – one in which, I argue, the new universalism of technoscience is reconfigured as an endless participatory promise invoking 'the people' as an agential whole. One that embodies the hope of bringing technoscience back to a truthful path, a path that both fixes and free from the mistakes of a technoscience polluted by monetary interests.

Figure 4.2 Cathal Garvey: a portrait.

Do-it-yourself: Cathal Garvey, 26, poses in the biology laboratory he created in his mother's spare bedroom.

Garvey poses in front of his lab bench and gestures the act of putting the gloves on and beginning working. The image is a screen-shot from the website hosting the article 'Doing Biotech in my Bedroom' published in 2012 on the MIT Technology Review, under the section 'Business Report' (Regalado, 2012). The screen-shot intentionally includes the advertisement juxtaposed to Garvey's picture to mark the synergistic management of content, where Garvey's laboratory is juxtaposed to an advertisement promoting a vision of manufacturing renaissance.

Despite the fact that, in the interview, he preferred not to further detail the reasons of his departure from his Ph.D. position, he later explained that it was the combination of his growing dissatisfaction with institutional science, and the positive echoes of Maker

Faires' participants that convinced him. In particular, the exclamations of enthusiasm from passers-by and witnesses of his public demonstrations offered him a counter-point to his belief that 'you are kind of used to think that you are somehow weird for liking biology.' Slowly but steadily, he begun to gather and source the different tools he needed to make of DIYbio into his career plan.

The size of a middle sized bed room, the laboratory consisted of two major areas, the bench and a small bureau with a desktop computer. Once we fixed the microphone so that he could walk and talk, Garvey approached the bench and started explaining his setting:

> ...so what I have here is, I wanted to create a microbiology set-up on a shoestring. Part of the reason I wanted it on a shoestring isn't just because I cannot afford better, but has a lot to do with I did have access to equipment or I would have been able to acquire access to equipment or methods that are closer to these institutional norm but actually wanted to live by the example because I can encourage people to take of this hobby but I wanted to be able to show them, I am not just telling you that you can do what I am doing I want to show them I am doing it on, as much as, a shoestring as possible so of course you can do the same.

In this last passage, just before beginning the description of the laboratory, the question then became: how to put biotechnology in people's hands. To do so, Garvey proposed that someone must show the example – a role that he took for himself. Garvey enacted his role by attempting to build a laboratory 'on a shoestring'[8]. He presents this attempt as an experiment of persuasion. By building it and working within it, he wants to empirically demonstrate that if he can do it, than everyone can, and that therefore biotechnology can be put in the hand of the people.

This first snapshot portrays Garvey's effort to problematize the political economy of contemporary biotechnology. On one side, as a young scientist, he understands biotechnology as holistic, part of a larger whole, and an opportunity to fix our mistakes. On the other side, his experience as a researcher is marked by the growing dissatisfaction with both private and public research. Both, he argued, are poisoned by the imperative of commercial values. In her work on the formation of scientific careers under the changing political economy of technoscience, Holden (2010) suggests that

8 The expression is commonly used by among DIYbio members to describe a multitude of practice ranging from establishing temporary laboratory-like settings as part of their public demonstrations, or functional home and community laboratories.

her interviewees invoked a 'Golden Age' of a public and fundamental research untouched by audit and managerial practices as a myth that gets them to 'do the job' (Holden, 2010: 224). Garvey's dissatisfaction, by contrast does not spare public research, and he dropped out, searching for a space to practice a different type of biotechnology. He proposed that biotechnology will only solve the world's problems once it is in the hands of the people. But what happens when Garvey puts its political theory into empirical practice? In the next snapshot I follow Garvey while he explains to me the making of his home laboratory.

Second snapshot – A tour of a laboratory on a shoestring

Garvey began the lab tour by describing the equipment, the consumables and then a number of basic procedures. At the time I visited him, establishing his laboratories and preparing experiences to be demonstrated during public events was actually what he was mostly doing. As he explained me: 'I'll start with the equipment that I'm currently using because it's probably the whole at the moment.'

The incubator

The first piece of equipment Garvey presents to me is the incubator. In microbiology and cell biology, an incubator is considered a common piece of laboratory equipment. Its temperature can be precisely regulated to enable or maintain the growth of a specific organism.[9] While Garvey used the same technical term, he explained to me how he assembled his one from a polystyrene box he received from his neighbour. He then bought a heat pad as an heating device, and a thermostat to control the temperature. Both components, he explained to me, are commonly used in reptile terrariums. He added:

> I found it's very good, but that's consumer pressure, you know, herpetologist**,** people who keep reptiles want high standards as microbiologists, so I have been happily surprised.

As a result, he claimed, the incubator is 'very achievable.' He further explained:

> it costed me very very little, in a pet shop you can get the thermostat for maybe,...maybe 30 euros or something like that, maybe less if you want go for a cheaper brand or get it second hand, or maybe more expensive but the point is it's very achievable, very easy to build.

9 More sophisticated incubators can also control humidity, oxygen and carbon dioxide concentration.

As he moved from explaining me how he built the incubator, to how he used it, Garvey's description become thicker:

> I have a small digital thermometer kind of taped into the inside as well, and to give a real impression of the actual temperature my cells are experiencing, the sensor for the thermometer is actually inside a Petri dish.

He continued by explaining that in order to obtain a homogeneous temperature inside the incubator, he positioned the heat pad vertically on the box's side, not horizontally on its lid, nor on its bottom.

Garvey, who has worked with professional incubators and cells, sets himself the challenge to construct a device with similar properties, but whose components are available to the potential 'everyone' imagined in his vision of a biotechnology for the people. As part of such a vision, one of his central preoccupations is to demonstrate the simplicity of the design, as well as the affordability and the availability of its components. Yet, when Garvey's explanations moved from how to build, to how to use the incubator, they become thicker. A digital thermometer is taped inside an empty Petri dish to record an estimate of the temperature experienced by the bacterial cells, and the heat pad has a specific position which is aimed at maintaining the most homogeneous temperature. It is at this stage that his extensive education and work in institutional laboratories comes in handy. The theoretical or practical knowledge he has acquired working with professional incubators is the one he relays upon to design the tool aimed at demonstrating that biology and biotechnology can be practised by everyone. Before drawing further conclusions, I would like to continue with Garvey's description of the laboratory.

Sterile conditions

After having placed the incubator back under the bench, Garvey moved on to describe how he worked under sterile conditions 'on a shoestring.' He explained that when working by himself, and because he is a trained biologist, he mostly used a camping gas cartridge with a Bunsen burner. However to avoid fire hazards when giving a public demonstration, Garvey uses a 'quickly sterilized plastic box.' The design, as for the first hands-on experiences carried by DIYbio members, was inspired by an article published in the Make Backyard Biology issue (see chapter Three). Garvey's hood consisted of a plastic box, of which a wall and the bottom have been partially cut off. The first entrance is for the hands of the user, while the second is where the High-

Efficiency Particulate Arrestance filter (HEPA) is positioned (see Figure 4.3). As for the incubator, Garvey praised the simplicity of the design. But while the HEPA filter is easily available, it is not affordable. Therefore Garvey gave me an additional tip: 'these [HEPA filters] are actually pretty expensive, 200 Euros but I got a new one with a damaged package on e-Bay for forty-five Euros and the box was free, I just recycled the box.' With the design explained, Garvay described how he established sterile conditions:

> I personally tested in my own lab by opening Petri dishes under the air flow leaving them there for a few seconds up to 20 seconds 30 seconds and then incubating them for up to 48h hours and seeing what grows and I had no growth. What I generally do, I have been spraying alcohol on the inside of the box and then flipping it over sterilizing the surface inside with, sanitize I should say with alcohol, with isopropanol alcohol…so I sanitized the inside with 70% isopropanol, ethanol is generally used but i'll get to that later, and once that it's pretty sterile, I allow for the propanol to sink and I wipe that away I turn on the HEPA filter [...] I leave it run for a while, and by leaving it run everything that might have settled in the filter, post filter, that is prone to coming out will generally come out so I might leave it on the highest,...when I am working with it, I might leave it working for a day in advance, when I set up for Maker Faire I went the day in advance I set it up and I let it run all night but I had decent results by leaving the thing up for 10 minutes cause 99% of what is going to come out is coming out in few minutes so once it is set up it's a pretty reliable pretty safe method of getting people involved.

As with the incubator, Garvey's descriptions thickened when he moves from the description of how to build the hood to how to use it. Sterile conditions, the empirical requisite, fundamental to the formation of modern microbiology as a discipline, requires the capability to design an experiment to detect contaminations. As such, the procedure described by Garvey relies on the knowledge build up in the experience of working under sterile conditions in professional settings. As for the incubator, what remains implicit in Garvey's explanations is that the way in which sterile conditions in a laboratory are guaranteed is as much a question of tools as one of practices. If, for Garvey, the problem of tools is, at least partially solved by demonstrating that their design is affordable and achievable and required only available components, the question of how to share the practice of using them seems less straightforward. As for

his incubator, the hood is portable. When organizing public demonstrations, Garvey take the tools with him.

Figure 4.3 The sterile hood.

Garvey sterile hood as showcased during the Newcastle Maker Faire in 2011.

For instance, using the sterile hood, Garvey proposed to the participants of the Newcastle Maker Faire to spread some *Bacillus Subtilis* on a Petri dish and bring it home. In this sense, the vision of putting biotechnology into people's hands, even when 'the people' are the participants of Maker Faires and science festivals, (see previous chapter) takes a very straightforward dimension. Yet, as for the incubator, the distinction between publicly demonstrating a laboratory procedure as being easy, and the difficulty of the practice itself as it is conveyed in Garvey's answer, remain unaddressed. After having stored his mobile sterile hood, Garvey grasped the next tool he wanted to present.

The DremelFuge: A handy centrifugal force

The centrifuge is another ubiquitous tool commonly found in the vast majority of contemporary life sciences laboratories. The instrument is used to separate a component of interest from a liquid sample, based on how the weight of different components reacts to an induced centrifugal force. Referring to the centrifuge as a 'glorified rotor,'[10] Garvey carried on his lab tour by telling me the story of the one he

10 As part of their attempt to 'demystify science,' DIYbio members have developed a discursive repertoire describing laboratory equipment as mundane, replacing terms understood as technical

made himself:

> When I started out in DIYbio I was working in an academic lab, I knew how a centrifuge worked, I had access to centrifuge every day, I could have done the hobby in the after hours in the lab, but there was no cheap, you know, DIYbio alternative at that time.

This time rather than re-purposing some components he bought or received, the lack of an alternative centrifuge became Garvey's occasion to design one. The moment coincided with him purchasing and installing his personal 3D printer[11]:

> It was just after having my Makerboat running [3D printer] so I just felt like at the top of the world, so let's just make a centrifuge, [Garvey is interrupted by his sister shouting from the stairs and asking if he is using some alcohol as she can smell it. Garvey answers that it is not alcohol but isopropanol, and it has a similar smell. He resumes our conversation] so I decided that I would try and design a centrifuge that could be printed. [...] I was just sort of thinking...what would...what could I make what's the low hanging fruits here, I had a Dremel next to me and I just thought, you get told...I mean a centrifuge as an example of this sort of thing that is overpriced, it's a glorified rotor, it's a big fast motor you stick things to and it's spins them, so I decided that I would design something and I put it together and I tested it.

To design the rotatory piece of the centrifuge, Garvey explained to me that he used OpenCad, an open source version of a Computer-aided design (CAD) software. Garvey's idea was to print a rotor holding the tubes containing the samples, a rotor that could be screwed on the rotatory head of a Dremel[12]. Once the Dremel is regulated at a certain speed, the rotor holding the tubes rotates and the liquid's components get separated according to their weight. He further explained:

> I was able to come up with a few quick prototypes and reiterate through these prototypes, the first was embarrassing looking and I even melted one trying to

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with other expressions. For instance incubators are often called 'heating boxes' or 'kitchen ovens.'

11 A 3D printer is a tool used to fabricate 3D object from a design file. The technique is mostly used in industry for rapid prototyping, but recently personal versions of 3D printers have been developed. In the previous chapter I briefly noted how these project have become part of 'the maker movement'. The Makerboat is a self replicable and open source personal 3D printer, his founders promote a rhetoric of distributed manufacturing (Söderberg, 2013)

12 The Dremel Multi-Tool, is a high-speed rotatory tool used for precision applications such as engraving, carving, routing, cutting, or sanding. The company, founded in 1932 is one of the major companies selling high precision tools for DIY and craft activities. The Dremel can be understood as another example of what Carolyn Goldstein has described in the case of the electric-drill, after 1945, when it became 'one of the first industrial-purpose tools to become a staple of home workshops' (Goldstein, 1998: 49).

> fuse the plastic in an oven. I was able to reiterate through a few design, print out a rotor that eventually worked when I clipped into it the tubes, the rotor was designed for the Dremel Multi-Tool®.

As he used the 3D printer for rapid prototyping, the accelerated reiterative process allowed Garvey to troubleshoot the design flaws quickly and at home. Garvey named the tool the DremeFuge, a playful composite neologism made of Dremel, the brand's name and 'fuge,' the last syllable of centrifuge. Once he was sure the rotor worked, he uploaded the design's file – under an open licence creative common license – on Thingiverse, the website of 'a thriving design community for discovering, making, and sharing 3D printable things.'[13] On it Garvey has a virtual shop called 'Labs From Fabs'[14]. Garvey also posted a video on YouTube explaining how to safely use the tool, and sold the rotor, for 44.10 Euros, on Shapeways, 'the leading 3D printing marketplace and community, empowering designers to bring amazing products to life.'[15]He also informed the followers of his blog, Twitter account, and the readers of the DIYbio mailing lists, that the tool was available.[16] Garvey added that he did so 'because I wanted other people to have access to this tool as soon as possible.'

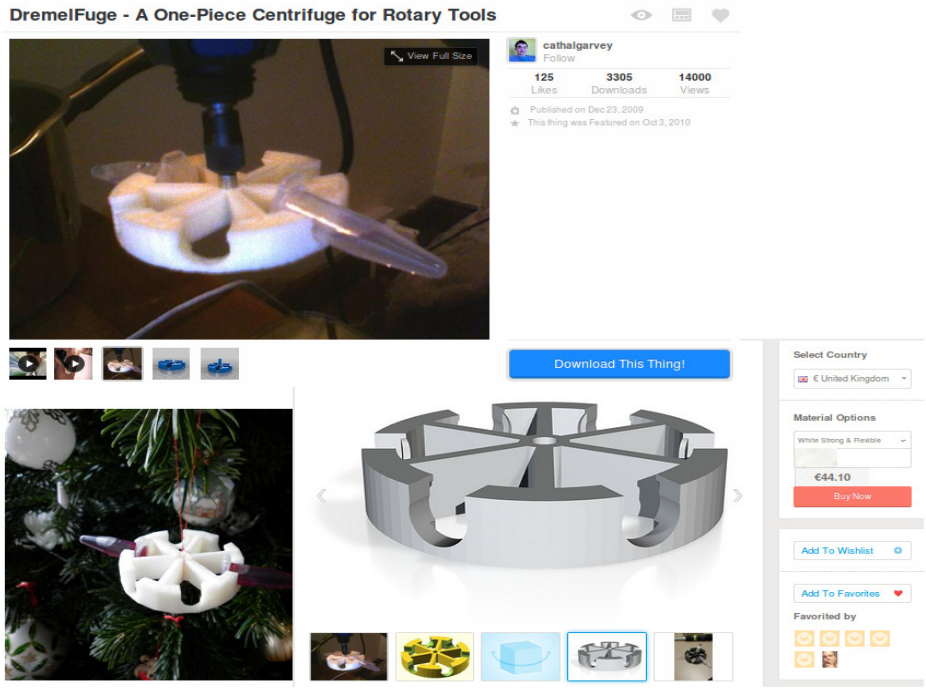
Figure 4.4 Sharing the DremelFuge.

13 Available at <http://www.thingiverse.com/about>. Last accessed 15 July 2013.

14 Available at <http://www.shapeways.com/model/77306/dremelfuge-classic.html>. Last accessed 12 September 2012.

15 Available at <http://www.shapeways.com/about>. Last accessed 12 September 2012. Shapeways is one the major portal of such emergent online economy, an example of what is more commonly referred to as 'personal fabrication' (see previous chapter).

16 Available at <https://groups.google.com/forum/#!topic/diybio/Nis5P4QRhYE and <https://groups.google.com/forum/#!topic/diybio/vS7XknvxM54>. Last accessed 12 September 2012.



In clockwise order from the top. A screen-shot from the Thingiverse web site.[17] The image of the Dremelfuge is part of Garvey's profile where the number of 'Likes,' 'Downloads' and 'Views' is indicated. A screenpring from the Shapeways website.[18] The third picture is the image that Garvey sent to the DIYbio Google Group mailing list with his wish of a 'Merry Whatever-You-Celebrate to you all, fine folk of DIYbio!'[19]

The DremelFuge can be understood as an additional example of how the question of availability is addressed by Garvey in practice. In this case, availability does not only refer to the sourcing of components, but also to the way in which the tool itself is made available. For Garvey, this means the members of his social media network, the users of the website where he uploaded the design, but also, in a sense the metaphoric 'everyone' of the universal Internet-user. Garvey also gives the putative user the possibility to build the rotor by himself. In this second case, the gesture of making something available takes the form of a file shared under creative commons agreements on Thingiverse. As making tools available to the people is the very first reality check for Garvey's socio-technical vision, this is again a demonstrative gesture. One that, once more, allows Garvey to live by the example, but that at the same time,

17 Available at <http://www.thingiverse.com/thing:1483>. Last accessed 15 July 2013.
18 Available at <http://www. shapeways.com/model/77306/dremelfuge-classic.html>. Last accessed 15 July 2013.
19 Available at <https://groups.google.com/forum/#!topic/diybio/l068LGWeJsY>. Last accessed 15 July 2013.

makes of him an example. It is thanks to the Dremelfuge that Garvey became a renowned and respected member of the DIYbio network, but also a case of interest for the media and scholars like myself.

Before drawing further conclusions, I would like to continue with Garvey's descriptions of basic laboratory procedures, respectively isolating and growing bacteria, choosing a model organism, and staining an electrophoresis gel.

Re-thinking bacteria isolation as a matter of hospitality

After having presented his equipment, Garvey went on by explaining how under the same principle one could carry out basic laboratory procedures. He began by explaining that being able to grow an organism of interest is an essential part of putting biotechnology in the hands of the people:

> [The medium] is what the bacteria are suspended in and the bacteria themselves. To make media,...nowadays if you are in a microbiology lab they just buy media from Sigma [a major laboratory supply company] but philosophically speaking what you are doing is you are creating something on which the bacteria can live, the bacteria already grow on something in the wild so it's often a matter of thinking what do they grow in there what can I make that would make them welcome.

The preparation of media is a central part of any microbiology laboratory. The knowledge acquired and used draws on decades of very often unsuccessful attempts to isolate micro-organisms from the wild, and maintain them in laboratories. Garvey's description of bacterial media displaces their preparation from the realm of microbiology to one of hospitality. Rather than describing it as a process that requires extensive knowledge in microbiology, organic and inorganic chemistry and molecular biology, Garvey turns into a question of hospitality, described as a simple matter of thinking what makes bacteria welcome. While making someone welcome can be harder than it looks, Garvey does not mention difficulties. Instead his encouraging claim is, once more, a descriptive way of opening up the challenge of bacteria isolation to the potential anyone of his imagined 'people.' He continues his explanation of how to prepare the media:

> I have made the equivalent of LB broth, luminescent broth [usually LB stands for Luria-Bertani, or Lysogenic Broth] using stuff you can buy in the shop and prove

> that you can make LB broth. So rather then buying tryptone[20] which is trypsinized whey protein, as a vegetarian I was kind of like, I wanna see if you can do it with something that doesn't involve tryptone so I went out and I got bromelain[21] which is a digestive enzyme that you find in a health store.

As in the case of his equipment, when Garvey begins to describe the actual procedure, his explanation thickens. He gives me detailed descriptions of which digestive enzymes can be found in health stores, or 'our family hippies shop'[22] as he also called it, and how they can be used to digest proteins. Garvey's source of protein is soy or another protein supplement also found in health food stores. He then digested the proteins by adding bromelain, a complementary digestive enzyme. As a source of essential aminoacids, additional peptides, water soluble vitamins and carbohydrates, Garvey used yeast extract. In its purified form yeast extract is sold by laboratory suppliers, but Garvey substitutes it with the comestible form available in local stores. In his explanation, what is striking is the relation between the familiarity of local food stores and the advanced knowledge of enzymes and food chemistry that Garvey uses to prepare his media.

Choosing and advocating a model organism

Garvey's explanation of how to prepare media and isolate bacterial from the environment, smoothly morphed into an issue that he has often debated both on the DIYbio Google Group™ and on his blog - i.e. which model organism could better suit a network of amateurs.[23] Garvey has often reminded the members of the network, that *E. coli*, widely used in institutional laboratories, is not a suitable organism. He explained it once more to me:

> E.coli it's surprisingly hard for an amateur to do and it likes 37 degrees, and funny you can get it 'til 32 really easily and you can get hundreds of degrees

20 Tryptone is a mixture of peptides, short amino acid chains, obtained from casein a family of milk proteins. In is commonly used as a source of protein to grow bacteria.

21 A digestive enzyme that works by breaking up proteins and facilitating their absorption by the digestive system.

22 The shop where Garvey's family do its shopping. On being a 'hippy' Garvey's writes on his blog: 'Your host is something of a hippy himself, complete with baking-soda-as-shampoo, vegetarianism and a litany of greeny car alternatives. For the record, though most hippies would disagree with my enthusiasm for genetic modification as an environmentally beneficial solution, I love hippies.' Available <http://www.indiebiotech.com/?m=201105> Last accessed 29 April 2014.

23 A boolean search for the terms 'model organism' and 'Garvey' in the DIYbio Google Group, reveals ten of messages in which Garvey promotes the conceptual importance of model organisms, pledges for the choice of *Bacillus subtilis*, or advises a new member on which organism to chose for an initial experiment. Available at https://groups.google.com/forum/#!searchin/diybio/%22model$20organism%22$20AND$20%22Garvey%22>. Last accessed 29 April 2014.

> easily you know what I mean, but there is a sort of horrible middle ground where there aren't any domestic reasons to have these temperatures therefore it's kind of hard to hack to have an incubator.

When he explained the design of his incubator, Garvey praised herpetologists' consumer pressure for making heating devices and thermostat affordable. In return, he told me, that made it possible for his incubator to be achievable. But now, when it comes to maintaining a growing temperature of 37ºC to cultivate *E. coli*, Garvey instead argues that this temperature is a horrible middle ground and that therefore *E. coli* is not a bacteria suited to amateurs. The available, affordable and easy to construct incubator reveals its limits, but this time Garvey did not attempt to solve the problem by finding a design alternative, instead he decided to change the organism to work with. According to Garvey *E. coli* presents additional barriers:

> I realized that there was kind of this huge barrier because *E. coli* was then the thing to do in biotech but it wasn't never going to fit nicely for DIYbio without a certain budget, biohacker spaces could probably pull in all the stuff you need, but amateurs...I mean...I couldn't...I wouldn't able to afford to buy an LB broth and the amount of time that I spent making and heating, a lot of time better spent doing work so I looked into *Bacillus subtilis* instead *E.coli,* its gram positive counterpart.

Garvey explained that, rather than spending time figuring out how to produce affordable, available and achievable media for *E.coli*, he preferred looking for another bacteria. The bacterial counterpart he chose was *B. subtilis.* He explained:

> I work with *Bacillus subtilis* rather then e.coli, because I feel that for DIYbio it's an all [single inaudible word] easy microbe, I have yet to prove my hypothesis that it's easier to hack because I have to wait for my license, but from an academic perspective I looked you know at the comparison between the two [bacteria].

At the time of our interview, Garvey said that he has not yet proven that *B. subtilis* is easier to hack because he had not then received his laboratory license to work with genetically modified micro-organisms at home. He also added that *B. subtilis* forms long-lived spores that can be stored and easily distributed. Lastly, he explained, 'the bacteria is known for being naturally competent, meaning that in certain phases of growth it should be able to easily absorb and adopt DNA.' Since then, Garvey has become an advocate for *B. subtilis*. For instance, in the first article dedicated to his

work, he is quoted explaining that *B. subtilis* is 'less smelly than *E.coli*, less likely to cause raised eyebrows or food poisoning, and could well be easier to grow and edit' (Regalado, 2012).

On his personal blog and on the DIYbio Google Group, Garvey spent a considerable amount of time explaining why *B. subtilis* is a suitable model organisms, but significantly less explaining the need for, or the purpose of a model organism. His implicit conviction that the choice of a model organism is an important decision for the thriving of the DIYbio network is, once more, a mark of his educational background as a trained scientist. Garvey identifies *B. subtilis* as a suitable model organism by progressively considering the constraints of not working in an institutional laboratory. As for the simplification of instruments and experimental design, the choice of a model organism to work with in a laboratory on a shoestring depends on Garvey having been trained to understand the purpose of model organisms and of having worked with them in academic laboratories. The simplification of laboratory procedures, including the one of choosing a model organism, seems once more not to be such a simple task. Lastly, if the work of Robert Kohler (1997) has shown that the choice of a model organism and the moral economy of the community gathering around it are intimately connected, in this case, it is a network in the making that Garvey wishes to gather around *B. subtilis*. The model organisms, is also in this case a demonstrative tool.

DNA visualization and the politics of sourcing reagents

Another passage that is recognized as obligatory in genetic engineering is DNA electrophoresis, where the technique, among others, is used in the process of preparing the genetic construct to be inserted and to verify the insertion of the desired gene in the organism's genome. After the OpenPearl Gel Box project demonstrated that it was possible to fabricate an affordable and available electrophoresis box, a second problem was posed to DIYbio practitioners by the fact that electrophoresis requires the use of toxic or expensive dyes to locate the DNA. On DIYbio Google Groups and other mailing lists, long threads often discussed the difficulties of purchasing dyes from companies, their prices, or toxicity, of most of the options.[24]

24 DNA staining is the revelatory step in DNA migration a technique used to separate DNA fragments by size. DNA samples (invisible) are 'loaded' on a transparent gel of agar that works as a sieve. At the end of the migration it is necessary to visualize the DNA; to do so the gel is stained in a bath containing ethidium bromide, which by binding to DNA molecules and becoming fluorescent when

At the time of our interview, concerned by the needs of the community, Garvey was working on another alternative. He was experimenting with the use of gentian violet[25] as an alternative to ethidium bromide. He explained:

> I am working with this method to come up with a nice in-gel method that's said by combining gentian violet, crystal violet and methyl orange in a correct molar ratio and pH for post gel staining and de-staining you can get as close as low as 8 nano-gram resolution [of DNA]. Ethidium bromide gets 4 nano-gram, but once you are below thirty nano-grams or whatever for most purposes that's more accurate of what you need, so I would like to have that up to working as an in-gel staining method to make it easier, make it quicker or whatever so that you can prepare loads of stock and then you can give it to people because I know how to do it to help pay the bills and tell other people how to do it so they can do it and avoid ever having to[single inaudible word] for a Sybersafe safe[26].

Garvey's passion for substitution is not only related to the issue of enabling amateurs to work as independently as possible from the economy of contemporary biotechnology. He is also concerned with safety and environmental issues related to laboratory work. Moving from the question of substituting reagents to one of sourcing them, Garvey went on by complaining that some reagents are difficult to find for 'silly reasons' that, as he indicated, have nothing to do with their intrinsic safety. For instance, he explained that as 'people have the habit to get drunk with alcohol' its availability is under restriction. As I asked him more about suppliers' policies, Garvey answered by telling me the following anecdote:

> I went into a chemist locally and I wanted a 100 lauric acid and at high molarity lauric acid is classed as a skin irritant, it's a strong acid but at low molarity it's not that dangerous really it's in your stomach if you vomit on yourself you will do more harm, but anyway he said ever since 9/11, they don't give away lauric acid, now Irish people have been bombing each other for decades and we were still allowed to buy it, but 9/11 which wasn't a bomb, was in another country, and has nothing to do with Ireland, then they stop selling...I was just blown away and Mistral still sells it, it's not that it's illegal it's just that they stop selling it you can find a seller online, they would ship it across the world even to you to get the

exposed to UltraViolet light, reveals the DNA. Because it binds to DNA, ethidium bromide is thought to be a mutagen compound and therefore its use is carefully monitored.

25 Gentian violet is an alternative dye that can be used to reveal DNA; the disadvantage is that its sensitivity is lower that professional dyes.

26 Sybersafe safe is a common non carcinogenic dye that is used as a – more expensive – alternative to ethidium bromide.

> chemicals you would need, but even with creative substitutions you can't get ethanol cause people kill themselves with ethanol all time with it because they are imbeciles, you can get isopropanol alcohol, it's not a perfect substitution but it's a very practical substitution.

In this passage Gravey names his own practice using the term 'creative substitution.' The theme of creativity, which accompanies most DIYbio practices, is here used in relation to laboratory practices.

Garvey's anecdote speaks about how national public health regulations and the politics of post 9/11 global security, get in the way of putting biology and biotechnology in the hand of the people. But if Garvey is not pleased that US foreign politics determines the availability of chemicals required for his laboratory on a shoestring in Cork, he is appreciative of another way in which, he argued, national regulations provide safe chemicals. In a conclusive passage recorded during our second interview, Garvey articulated his major socio-technical vision of a safe biotechnology available to all, based on an economy described as local and independent. He wondered:

> I don't know, would you call this genetic sovereignty, to acquire genetic sovereignty...I want to be able to say that no matter where you are in the world, and no matter how oppressive the regime you are under you can do DIYbio. So say you live in a country where it is illegal to do PCR on yourself, like in America, you are not allowed to do PCR on 60% of you genome and in Europe in fact because it's patented, and my answer is no, that is crap, of course you should be able to do that, so assume that someday that they decide to have they corporate bodies to make it illegal to do PCR at home, I would like people to do PCR anyway and I try to think of ways, how would people do that anyway, how they can make the buffers at home using homemade solutions, how they would grow the enzymes at home using something that they can have from their local genetic group to grow the enzyme and then they can get plasmids, and primers, how would they do that, so I do think at that as well and incidentally leads to very safe practices because you are talking about ways of getting chemicals locally, and in order for a chemical to be available locally it has to pass some safety test anyway so incidentally it also lead to safer practices.

This last passage is marked by Garvey's descriptions of doing science as a right to be defended. Similarly, other DIYbio members have claimed that scientific enquiry is a right comparable to freedom of speech. But, for Garvey to defend this right in practice, it means to come up with creative substitutions that not only are affordable and

available, but that can be so even under oppressive regimes. In the passage, these are described by Garvey as countries where for patenting reasons, doing PCR on one self might be illegal. In particular, the last part of the passage ties together several elements of Garvey's vision of a holistic biotechnology. In an attempt to make a biotechnology independent, Garvey imagines that the enzymes required for a PCR reaction could be produced at home. As he explained, that would incidentally lead to safer practices. If the issue of affordability and availability are still central for the sourcing of reagents, the issue one of safety seems a consequence of Garvey's understanding of a economy of local reagents. Garvey puts a lot of effort into finding creative substitutions that are affordable, available but also safe for the environment and for the users. The notion of safety described by Garvey is tightly related to the use of home-made solutions. As he explains for chemicals to be available locally, it means that they have passed safety tests, and that therefore they are safer. A holistic biotechnology is therefore one that is affordable, available and achievable, based on a local economy that intrinsically makes it safer. As the tour of the laboratory came to an end, Garvey concluded:

> So I do feel like the basic set up I have up here could probably go out and take someone out there and say, look you can do this, the price of all my equipment and chemical, so far it has been bout 2300 Euros, but I have bought a lot of redundant things, I have been meaning to go through, pick up what you actually need and come up with a price tag.

In this second snapshot I followed Garvey as he described his laboratory on a shoestring, tracing the demonstrative effort of turning his political critique of biotechnology into an empirical practice – one that he would even eventually provide a living for him.

Garvey's descriptions are marked by his efforts to produce equipment and procedures that are affordable, available and achievable. This includes the design and the assemblage of tools, as well as the sourcing of reagents and model organisms to work with.

From Garvey's description, affordability stands for the design of laboratory instruments that do not exceed the costs that he estimates as affordable in comparison to the price of the professional versions: an incubator for less the fifty Euros, a sterile hood for forty-five Euros, a centrifuge rotor for forty-four Euros, etc. In calling the centrifuge a 'glorified rotor,' Garvey expressed his discontent with the inflated prices

of mundane laboratory equipment. As with other DIYbio members, Garvey criticized these price as being viable only because researchers in wealthy countries can afford them, but mostly because for DIYbio member these prices constitute a barrier of entry to biotechnology. Providing cheaper equipment is, for Garvey, a way of enabling his vision of a biotechnology available to all and therefore less poisoned by commercial values. Garvey, like other DIYbio members, is not ignorant of the fact that laboratory equipment is reliable and precise under a range of conditions. But for him his commitment to search for affordable alternative is greater than his need for absolute precision.

The theme of availability refers to Garvey's practice of searching for substitutions that are easily accessible in one own surrounding. In Garvey's case this means the situated surrounding of Cork, a wealthy European city, but also the extended surrounding of the Internet as an endless market place. Availability is not only a condition guiding the choice of components, but it also informs the practice of making available the instrument that is thereby constructed. In the case of the DremelFuge, as for other instrument produced by DIYbio members, this means selling the instrument, as well as uploading its design files online. Additionally, as most of Garvey's instruments are also mobile, he uses them as part of his participatory public demonstrations, thus enabling Garvey to teach the conditions of laboratory work to 'the people' outside his laboratory. Lastly, and especially in respect of reagents, Garvey explained how, for him, availability is also tied to the notion of safety. By sourcing chemicals locally, he explained, they are intrinsically safe but also minimize his reliance on large corporations' services. The notion of availability is therefore intimately linked to the notion of an independent biotechnology, one that can be practised under oppressive innovation regimes.

The third theme, or condition, for the design of laboratory instruments aimed at putting biotechnology in the hands of the people, is that their construction should be achievable - a term that Garvey repeats on multiple occasions. If affordable and available refers to the economy and geography of his practice, achievable concerns their epistemic status, intended as the imagined capacity of 'everyone' to construct and work with laboratory tools and reagents. If affordability is, in a sense, a critique of the price of laboratory instrument as a barrier of entry, Garvey's search for laboratories instruments and reagents whose construction and use is achievable, reads as an

additional demonstrative gesture, this time aimed at the educational system. As expressed by Mackenzie Cowell, the DIYbio co-founder, as well as others members of the network, Garvey express his criticism toward the educational system by claiming it is elitist, and thus his commitment to searching for 'better way to learn.' Garvey's attempt to substitute professional components and reagents with mundane counterparts is at the core of his practice. These are what he himself called 'creative substitutions' – a practice that enables him to turn his political critique of contemporary science into an empirical practice, aimed at establishing a holistic biotechnology, one that is decentralized, local, and dependent only on the financial resources of 'the people.'

My point in summarizing these design principles, and in understanding how they enable Garvey to enact his critique, is not to show that Garvey's practice is unique. Instead, I became progressively attentive to what I came to call the *thickening* of Garvey's explanations. By using this term, I have tried to pin down some of the explicit and implicit difficulties that he encountered, and the types of knowledge or experience he relied upon to solve them. I have also tried to pay attention to how the simplicity of his initial descriptions belies the complexity and the depth of his knowledge. These, I argue, are my entry point to understanding Garvey's philosophy based on the principle that if he can do it, than everyone can as well. Garvey's is a scientist who also thinks of himself as 'the anyone' in question. As Garvey's explained, one needs to stop thinking as a researchers in an institutional laboratory. But to do that, first one needs to know how a researcher thinks. In the thickening of Garvey's description, I read the reconfiguration of universalism as a scientific endeavour, performed through a meritocratic assumption that if one person can do it, then everyone can, or should be at least interested in doing it. This is a position, of course, whose idealism is based on the effacement of one's own situated cultural biography.
Garvey describes himself as the enabler, the one who needs 'the people' to fix the poisoned morality of biology and biotechnology research agenda; someone who is committed to the development of a practice demonstrating that a biotechnology for everyone is indeed possible, even if by doing so his educational and personal experience is made invisible. In the following and last snapshot I retrace one of the Garvey's most ambitious experiment, the IndieBB plasmid, aimed at putting biotechnology in the hand of the people.

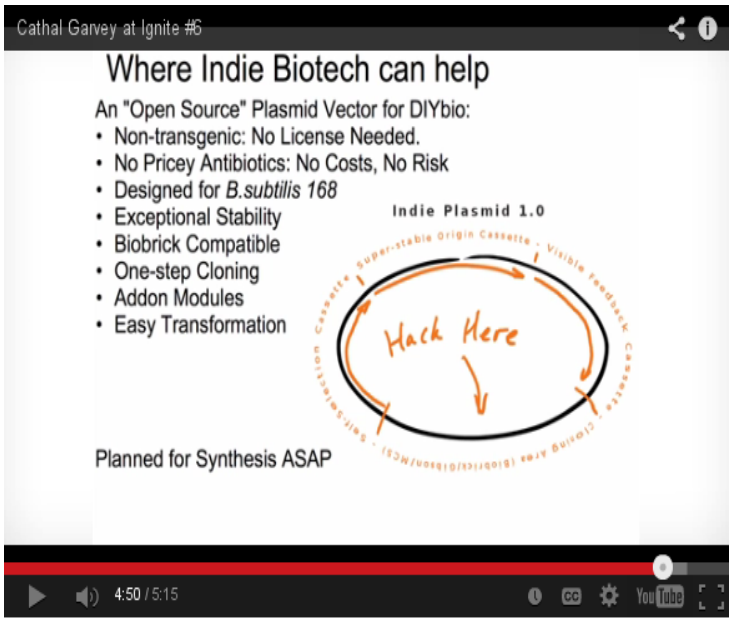
Third snapshot – IndieBB a holistic plasmid

When I first visited Garvey, he was mostly occupied with finding creative substitutions and designing simple and portable educational experiments to be showcased at outreach events. But as part of his demonstrative effort, the possibility of producing genetically modified micro-organism was one of Garvey's ultimate goals. At the end of 2011, after months of bureaucratic procedures, Garvey was granted a year-long Class 1 Laboratory license to work with genetically modified micro-organisms at this home laboratory. Thus a bit of his parents' home became a legally recognized Class 1 Laboratory – a reconfiguration which reminds me that, it seems easier to turn a bit of a home into a laboratory, then turn a laboratory into a bit of a home. Furthermore, this additional tool allows Garvey to pursue his ambitious project of constructing the IndieBB.

Garvey began working on IndieBB in 2011, and continued at least until March 2014. The composite neologism IndieBB makes use of the term 'indie,' a shortening of 'independent' that Garvay has adopted from the indie music movement. It also incorporates 'Biotech,' as the short version of biotechnology, and 'Backbone' a term commonly used in microbiology to indicate the portion of a plasmid coding for two instrumental functions: duplication and expression. In this context, the term backbone also suggests an additional foundational role; the IndieBB is in fact aimed at enabling and maintaining the practice of an independent biotechnology.

During one of his Ignite talks in 2011, Garvey for the first time publicly presented the project of "An 'Open Source' Plasmid Vector" for DIYbio. He argued that as tools used in the laboratory 'are not appropriate,' the plasmid would provide a solution to the 'unmet needs' that were supposedly preventing individuals from practising DIYbio.

Figure 4.5 Presenting the IndieBB plasmid.



A Screen shot from Garvey's blog where he has embedded the video of his talk.

As with Garvey's rotor, the project is available online. On GitHub,[27] he described it as follows: 'IndieBB is a project to create an antibiotic-free, modern cloning plasmid under a permissive EULA[28] as close to 'Free/Libre' (think Affero-GPL)[29] as manageable. This repository will host the working materials for the plasmid itself, when they are ready for release.'[30] But what does it mean to provide an appropriate tool for the unmet needs of amateur biologists? And what type of appropriate tool is the plasmid IndieBB?

In silico and in vivo stabilisation

As shown in the previous snapshot, Garvey is a strong advocate of using *B. subtilis* as a model organism. But if Garvey has demonstrated that he can grow the bacteria using his incubator, he now has to show that the bacteria can express the in-the-making genetic functions of a biotechnology for the people. To do that, Garvey needs to

27 GitHub 'is the best place to share code with friends, co-workers, classmates, and complete strangers. Over six million people use GitHub to build amazing things together.one of the largest online community where to share and collectively work on software.' Available from <https://github.com/about>. Last accessed 2 May 2014.

28 An End-user licence agreement (EULA), is the general legal agreement that is established between the manufacturer and the end user of a software.

29 Affero is a rating and reputation service for online volunteers. The Affero General Public License was an adaptation of a General Public License enabling authors of software used over the internet 'to download the source and receive the benefit of any modifications to its original work.' Available from <http://www.affero.org/oagf.html>. Last accessed on 19 May 2014.

30 Available from <https://github.com/Glowbiotics/indiebb>. Last accessed 2 May 2014.

demonstrate that *B. subtilis* is easy to 'hack.' One of the criteria for chosing *B. subtilis* was that the bacteria is 'naturally competent.' But, as he later explained to me, the problem is that if *B. subtilis* is naturally capable of up taking DNA, it also tends to lose the plasmid from one generation to another. In industry and academia, Garvey added, the problem is solved by using *E. coli* to make copies of the plasmid, transferring the plasmid in *B. subtilis* only for the expression phase, and maintain it using antibiotic selection. Again, Garvey argued that in industry and academia this is not a problem because a lot of money can be spent on antibiotics.

To stabilize his plasmid and his imagined community, Garvey therefore needs to figure out how to reduce the bacteria's tendency to lose plasmids, as well as to select for the plasmid without using antibiotics. For the first step he used a software to virtually redesign the plasmid's sequence on his computer. Garvey decided to delete the topoisomerase, a gene that, as he explained, is implicated in the instability of the plasmid. He also decided to add a gene coding for a protein synthesizing the complementary strand of the single-stranded DNA, thus turning the single strand plasmid into a more stable double DNA strand. He commented that 'a bit of research reveals, there is a reason why your plasmid is unstable and most industrial plasmids they haven't bothered putting this single stranded origin back in.'

Once his plasmid stabilized *in silico*, he still needed to design a system to select for the bacteria that have integrated the plasmid *in vivo*. Garvey knows about the costs of antibiotics, but he is also concerned about amateurs using antibiotics. He continued: 'bacteria with antibiotics resistance genes could end up down the drain as well and hand those off to a much more dangerous neighbour and it's expensive and awkward getting antibiotics.' For the plasmid to be maintained without using antibiotics, Garvey tried different designs. In his first design, he tried to restore *B. subtilis*'s swarming mobility under sucrose induction. The idea was that bacteria with the plasmid would be able to 'swim away' on the media and therefore become recognizable. On March 2011, he announced on his blog that he had placed his first order for the synthetic plasmid with Epoch Life Sciences, a DNA synthesis company based in Texas, US. On the 21 April 2011, he announced on Tweeter that the plasmid had arrived.

When I first interviewed him in May 2011, shortly after he had received his first synthetic plasmid, Garvey claimed that the system worked. I met him again, in March 2013, and asked him some updates on the project, as the blog had been dormant for

several months. Garvey mentioned that he had to re-do some of the experiments because his culture might have lost the plasmid. When the IndieBB crowdfunding campaign was launched in January 2014, the project's description indicated the use of another selection system.[31]

In socio stabilisation

For Garvey, stabilizing the plasmid is not a problem that exists only at the genetic scale. For him, it also means to guarantee that, once he releases its design on the Internet, no one will be able to patent the plasmid. Garvey is a strong advocate of free and open-source software, and more generally of the way in which the movement is fuelling the re- emergence of discourses and practices aimed at establishing an open society. While other DIYbio members are open source sympathisers or even patent friendly, he has no problem stating that patents are simply 'evil.' During our first conversation, Garvey expressed that he would like an equivalent of an open source license but for DNA. He specified that he did not want to simply put it in the public domain, because it could be leaked back into private property. So while the backbone would be very similar to a Material Transfer Agreement[32], he says it would be 'a whole different breed of MTA, an MTA that shares and shares alike and gives credit where it's due, and that's it you can use it to make profit, you can use it to do anything you like as long as you don't try to patent it out of reach, force people to do things on your terms.' In this context the term 'viral' refers to the 'nature' of the agreement that has to be passed on unchanged. He explained to me that his reasons for chosing a 'share alike' 'copy left' requirement came from examples in the software industry where companies that have either patented their product as a defensive gesture, or simply released them in the public domain, have later seen their patent portfolio being bought or their public work being copyrighted or patented by other companies. Even if, by defining its moral economy, Garvey has thought about how to stabilize the plasmid in the bacteria, and the circulation of the plasmid in the network, Garvey still needs to stabilise another fundamental economy – his own.

31 As Garvey will eventually fail to stabilize his plasmid 'in economico' (see last section), I am unfortunately unaware of the empirical status of Garvey's alternative selection system.

32 A Material Transfer Agreement is a form of contract that governs the transfer of materials from an owner (or authorised licensee) to a third party for internal research purposes only. It is a common contract used in research laboratories to share materials such as cultures, cell lines, plasmids, nucleotides, proteins, bacteria, transgenic animals, etc. that are patented.

In economico stabilisation

As I mentioned in the introduction, when I first met Garvey in 2011, he was unemployed and, as he put it ironically, 'a kept man.' Four years later, and with several thousands of Euros spent on equipment and especially on DNA synthesis, Garvey needed to stabilize his own economy. Within the DIYbio network, a common yet precarious form of economic stabilization is the production and selling of educational kits and cheap laboratory equipment (see previous chapter). If these activities are perceived as a demonstrative gesture, they also tend to be successfully funded via crowdfunding initiatives. Since 2008, and following the increasing popularity of crowdfunding practices, several projects from the DIYbio network have successfully used this method, in particular using Kickstarter[33]. Garvey instead chose to gather funding using IndieGogo, Kickstater's major competitor[34]. The campaign, 'IndieBB: Your First GMO,' started in January 2014. In the promotional video Garvey, dressed in his lab coat explained:

> By making your own genetically modified bacteria and learning the methods and principles of synthetic biology, you are becoming an informed member of a group, a growing global community of citizen scientists and DIYbiologists. By making your own fluorescent cells you are developing a skill set and a knowledge that enables you not only to make informed decisions on the subject, but to take the first step on a potential hobby or career in synthetic biology, which is widely touted as one of the most significant and transformative technologies of the coming century.[35]

Garvey evaluated that for all his efforts to finally realize a kit, he needed to raise 16,000 Euros. In the FAQ's section, he wrote that the money will cover fourteen weeks of work, the synthesis of three plasmids and laboratory material. Under the question 'Why are you paying yourself €3000 for 3 months' work?' Garvey explained:

> It's unfortunate that this was even asked. One hopes, firstly, that the questioner is aware that this is far below minimum wage in Ireland. It may come as a surprise,

33 The most recent and iconic being Glowing plants: Natural Lightning With no Electricity, a project based in the Silicon Valley in California. The founders sought $65,000 and received $848,013, with the aim of providing genetically engineered plants that glow in the dark as alternatives to lighting.

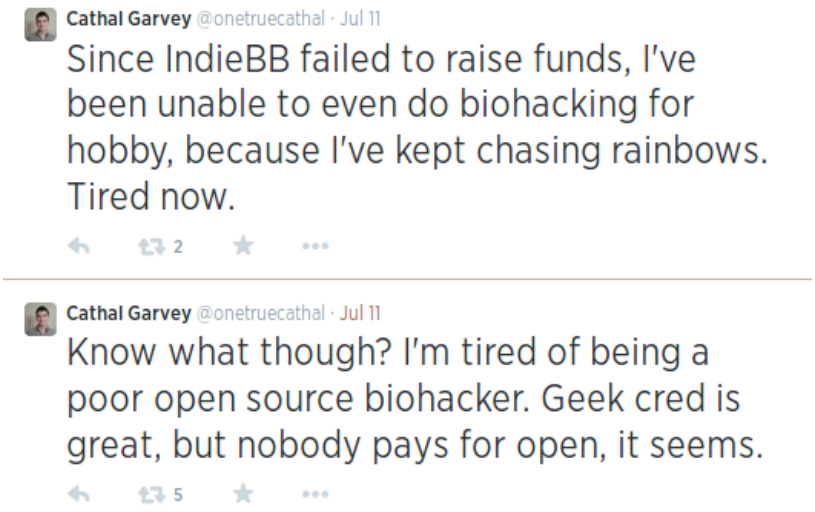
34 Crowdfunding is the practice of using the Internet as a fund-raising tool. Kickstarter, 'Bring creative projects to life,' is aimed at film makers, musicians, artists, and designers. By contrast, Indiegogo, 'Together Do Anything,' supports more technology-driven projects, from watches projecting the hour, to helping orphanages by installing solar panels. Respectively available at <https://www.kickstarter.com/> and <https://www.indiegogo.com/>. Last accessed 2 May 2014.

35 Available at <https://www.indiegogo.com/projects/indiebb-your-first-gmo>. Last accessed 2 May 2014.

> and I am aware I appear much younger than I really am, but I have a family to help support! I might survive on less per month if I lived with my parents and ate noodles all the time, but I have a mortgage to pay for, kids to feed and clothe, and must still contribute to our costs. For all this, I'm passionate about synthetic biology, and more so I'm passionate about helping to create an open-source revolution in biotechnology. Sadly, nobody out there is yet offering careers in open source biotechnology, and so I have no recourse but to do it by myself as a full-time job. €1000/month means that I can justify giving this my full-time work to make it happen. Without that money, I literally would run out of money and would have to seek alternative employment, relegating IndieBB to a weekend project, spared only the time between parenting, work and the necessities of continued survival. I can guarantee the questioner that any project of comparable complexity that doesn't include 'living wage' in the cost plan is just hiding it among the other costs. One cannot survive upon goodwill alone.

A month later the campaign closed at €11,716. Garvey did not hit the threshold and therefore the money was given back to the individual backers. The campaign, as he put it, failed. In a last post published on the campaign web site, and entitled 'Doors Close, Doors Open'[36], Garvey wrote that the failure had been a steep learning curve, but that recent and tireless effort in the Cork-based bio and entrepreneurial communities nonetheless gave him a 'sudden, immanent feeling. Something's brewing.' The most recent public appearance of IndieBB is on Garvey's Twitter, when in April of this year he wrote:

Figure 4.6 A Print screen of Garvey's Twitter account.



36 Available at <https://www.indiegogo.com/projects/indiebb-your-first-gmo#activity>. Last accessed 2 May 2014.

Gravey's Tweets, and his description of himself as 'being a poor open source biohacker,' are brutally honest about the economic difficulties he encountered as he tried to remain truthful to his own principles of a holistic biotechnology. But they also show how such difficulties have bent his idealism, which he now dismissed by calling it 'chasing rainbows.'

In this last snapshot, I have traced the making of IndieBB as Garvey attempted to stabilize an independent biotechnology by providing a backbone in the form of a plasmid. I argued that Garvey first identified, and advocated the use of, *B. subtilis* as a model organism around which an imagined community of DIYbiologists could gather. He then designed and tested a plasmid whose aim was to express the genetic functions of a biotechnology for the people. This required Garvey to find an alternative to the use of antibiotics. But the stabilisation of the plasmid was not only a microbiological issue. By providing a hybrid MTA Share alike license, Garvey hoped to guarantee that the plasmid would freely circulate in the community and would be protected by attempts to leak it into private property. More importantly, the last process of stabilisation involved Garvey's own economy, which, after years of personal investments, sought the financial support of the 'individual' whose needs he was, supposedly, about to meet. In the form of a kit, the IndieBB becomes Garvey's entrepreneurial gesture, aimed at demonstrating that one can live through an independent and personal biotechnology. As a gague of Garvey's critique of how monetary interests have poisoned scientific research, his funding request remained modest. And yet all of this efforts, the crowdfunding campaign fails, and Garvey tweets about his difficulties in remaining truthful to one's principles in the face of economic difficulties.

In tracing the most ambitious experiment that Garvey performed in his laboratory on a shoestring, my point is not that the success or failure of Garvey's campaigns marks the success or failure of his demonstrative effort, and therefore the significance or insignificance of DIYbio practices. Nor is my aim to provide here a critique of the socio-technical vision of a personal biology. Instead, Garvey's struggles enable me to return to the question of how one turns a political critique into an empirical practice. What does it takes to stabilize a political critique into an empirical practice? And what that might mean in the case of proposing an alternative to the contemporary political economy of biotechnology?

Conclusion

In a corner of the densely written 'Give me a laboratory and I will raise the world,' Latour describes how Pasteur tried to get elected himself as a senator, but was unable to get more than few votes. Instead, Latour argues, it was in the laboratory that Pasteur modified society's organization, 'directly – not indirectly – by displacing some of its most important actors' (Latour, 1983: 156). Latour's attempt to show how, in our modern societies, power comes more from science then from classical political processes, Pasteur's case is used to illustrate how the macro level (the 'social context') and the microlevel (in this case the meticulous laboratory work of rearranging anthrax at the miscroscopic level), as well as Pasteur's broader alliances, are intimately related.[37] The title of the article, and its contents, are strangely evocative of Garvey's practice. But if Pasteur's problem was anthrax, and he made part of his glory and most of his finances out of it (Chevallier-Jussiau, 2010), Garvey's problem is what he sees as the poisoning of both private and public research with monetary interests. This poisoning, for Garvey, undermines research's capacity to solve the world's problems. Instead of yearning for a 'Golden Age' of a science immune from financial interests as a myth that gets him to 'do the job' (Holden, 2010: 224), Garvey drops out. He does not want to do the job. I argue that what Garvey is doing, at the microscopic scale of his home-made laboratory on a shoestring, is trying to turn his political critique of biotechnology into an empirical and demonstrative practice – one that he can, finally, live with but also live by.

The laboratory on a shoestring is a utopia-in-the-making, a non-place that Garvey sets himself the task of establishing in order to demonstrate that a holistic biotechnology for the people is possible. But for the laboratory to be, once more, a tool to raise the world this time Garvey needs the help of the people. Latour shows that the laboratory is one of the places where scientists re-organize society. Garvey's examples of an holistic biotechnology, by contrast, shows us that the laboratory can also be the place where scientists attempt to re-organize the politics of technoscience itself. At the core of his proposition is that it is only when it is in the hand of 'the people' that biotechnology, in a sense, will be freed from the imperative of commercial values. In a sense, as Garvey attempts to re-organize technoscience, 'the people' become his tool to

37 Latour's article is also a methodological and theoretical statement challenging the divide between macroscopic studies of science and technologies and microscopic studies of laboratories practices.

fix biotechnology. It is by enabling 'the people' to do biotechnology that the technology will produce benefits for humanity. If he explicitly describes his practice as one characterized by creative substitutions, it seems that Garvey's political theory is also, in its turn, re-configured by creative substitutions. In simple terms, instead of fixing people's problem with biotechnology, he attempts to put biotechnology in the hand to people to 'fix biotechnology.' The invocation of 'the people,' used as a synonym of 'humanity,' appears as a new universalism of technoscience, one reconfigured as an endless participatory promise invoking 'the people' as an agential whole.

In the second snapshot I followed a holistic biotechnology in-the-making, as one in which, via creative substitution, Garvey attempts to establish a laboratory practice that is affordable, achievable and for which components are available; a practice for which products can be used without an extensive knowledge of the field, or without great financial resources, and that are protected from patenting attempts; a biotechnology that that will be decentralized, local, and dependent only on the money of 'the people.' However, in this section, I also argued that when Garvey explained the actual use and maintenance of the instruments, his explanations thicken, suggesting that in his attempt to reform the politics of technoscience, Garvey takes for granted his own knowledge as a scientist.

This last point brings me back to the ambiguity of scholars' interpretations of DIYbio practices, in which these practices are mostly positioned both as unique and significant, while also being criticized by exposing the limits of their participatory promise. When thinking of these propositions, with Garvey's last Tweets about the IndieBB project in mind, the question of how to understand these practices shifts once more. Just as Latour described in his paper on Pasteur (1983), I argue that Garvey's experiments only work on the condition that the laboratory setting is respected. In this sense, putting biotechnology into people's hands is not about questioning what it means or takes to adapt it to their needs, or how one can even know what 'the people's' needs are in the first place. Instead it implies inscribing their needs as part of the possibilities of a personal biology and biotechnology.

5. On being good biocitizens: ethics as a process

How do we build a positive culture around using technology and become good biocitizens?

Jason Bobe, DIYbio co-founder, 11 March 2011, Washington D.C.

Introduction

In June 2008, a couple of months after the first DIYbio meeting in Boston, Markus Schmidt, a biologist retrained as a technology analyst, published a paper about the biosafety concerns to be expected from the emerging field of synthetic biology (Schmidt, 2008). Under the terms 'biohackery' and 'biohackers,' DIYbio projects were mentioned as one of these concerns and described as follows:

> Biohackers might spark a wave of innovation unseen in corporate research programs. [...] Imagining a world where practically everybody with an average IQ would have the ability to create novel organisms in their garage without adhering to a professional code of conduct filing a reporting system and lacking a sufficient biosafety training, is a thrilling thought. If it is true that there is a kind of informal code of ethics for the hacker community [...] This hacker ethics, however, did not and could not prevent tons of malware programs out there in the worldwide web. The more successful the attempt to program DNA as a 2-bit language for engineering biology becomes the more likely will be the appearance of 'bio-spam, biospyware and bio-adware' and other bio-nuisances.

The paper was only the first of a series of hostile press published in science journals such as Nature (Bennett *et al.,* 2009), technology law journal (Gorman, 2011), but mostly in the mainstream media. As did Schmidt, journalists exploited the self-fulfilling analogy between computers and biological viruses warning the reader about the hypothetical release of deadly microbes (Johnson, 2008). Others referring to the supposed fear of the public for GMOs, accused DIYbio of producing Frankenstein's monsters (Ayres, 2008; Degasne, 2008; Wahlen, 2009); disseminated the opinion that biohackers could inspire bioterrorists (Ayres, 2008); be a global threat (Russia Today, 2009); be a threat to national security (Wahlen, 2009); release

synthetic viruses (Wahlen, 2009 and The Economist, 2009) or create mutant viruses (Zimmer, 2012). Broadly speaking, these discourses repeatedly associated DIYbio members to either bioterrorism, as a post 9/11 social construct (Wright, 2007), or to the figure of the computer hacker as a deviant individual with a suspicious morality (Jordan and Taylor, 1998). At the same time, these discourses also presented biohacking as a potential site for unprecedented technological innovation. Following these events the computer hacker analogy, since used by a majority of DIYbio members as a rhetorical tool, slipped from their hands and ended up sustaining a range of hostile discourses. The 'benevolent' socio-technical vision of a personal biology was in danger. It was during this period, that, in front of an audience composed of American governmental agencies, Jason Bobe, the co-founder of the DIYbio network, asked the following question: 'How do we build a positive culture around using technology and become good biocitizens?'

Framed by Bobe's question, this last empirical chapter continues my project of exploring what I provisionally called, the making of a personal biology. In particular, it is through a detailed description of the DIYbio European Congress, aimed at establishing a code of ethics for the DIYbio network that I try to figure out Bobe's notion of a 'good biocitizen.'

In the first chapter I described how DIYbio members used social media to both elaborate their identities and the socio-technical vision of a personal biology. I claimed that by assimilating the political economy of social media they produced a user-friendly biology. A biology and a biotechnology that could be shared and enacted via blogs posts and other social media. I concluded that by addressing 'the people' as an abstract figure of reference for a personal biology and biotechnology, DIYbio members reconfigured the participatory tone of digital technology as a new universalism. In the second chapter, I moved from the discursive practices in hyperlink, to the first hands-on activities performed by DIYbio members. To do so, I took a rather long detour, situating the DIYbio network as part of a curatorial practice: The MAKE. I argued that the political theory sustaining the socio-technical vision of a personal biology, is one of the empowered individual as an endless resource of innovation. In the third chapter, I looked at 'the reality' of such a vision by detailing a home laboratory built by an early and influential member of the DIYbio network. In following his experiments, including the one of establishing a

home laboratory, I argued that a personal biology is an empirical practice of negotiating one's own political consciousness in a specific attempt to reform at least a number of problems within mainstream science. While throughout this thesis the question of values is addressed on several occasion, this last chapter focuses on the explicit elaboration of a code of ethics for a personal biology.

The question of the ethics or moral values of DIYbio members had not only been a preoccupation of analysts and the media, but also of scholars. In her preliminary work Sara Aguiton (2009) proposes that members of the DIYbio network participate in the replacement of *community norms,* as theorized by Merton, with what she names 'critical individualism' (2009: 40). A type of reflexivity according to which the adoption of moral or ethical criteria is no longer necessary, instead, 'difference and divergences are accepted and regarded as a possibility of new and innovative ideas' (2009: 40). Moral norms are also the point of entrance for Alessandro Delfanti's work (2010). He argues that in the last year a 'remix' of the Mertonian norms and the ethics of the computer hacker has emerged in the life sciences, and that biohackers are an example of it. Quoting Luc Boltanski and Laurent Thévenot's work on the 'imperative to justify' one's search for a new ethical norm, Delfanti understand such 'remix' as the symptom of a crisis in the proprietary regimes of biotechnology (Boltanski and Thévenot, 2006 cited in Delfanti, 2010:19). While both authors are concerned with the emergence of new moral types as a sign that the life sciences become even more intertwined with neoliberalism, both think of these transformations either as a departure from, or a remix of, the conceptualization of scientific norms as proposed by Robert Merton (1972).

In thinking about what it means to be a good biocitizen, and by extension what might be an ethics for a personal biology, I use Patrik D. Fitzgerald's critique of Merton's approach (2012). He argues that although Merton speaks about mores, intended as 'sentiments embodied in the ethos of science, [but that] what is notably lacking in Merton's description is […] the memory of a specifically emotional and affective undergirding in this (nonetheless) scientific ethos' (Fitzgerald, 2012: 121). Following his argument, my aim is also to think more generally of Haraway's notion of 'ethical relating,' something that she describes as 'knit from the silk string thread of ongoing alertness to otherness-in-relation. We are not one, and being depends on getting on together.' Or, as it is formulated by one of her biographers 'this

commitment to paying attention to and living with what we cannot know but that which we love helps us see, says Haraway, the essence of ethics in relating' (Schneider, 2005: 83). If Fitzgerald's commitment aims at establishing a different understanding of the relationship between neuroscientists and autism as their research subject, for Haraway's ethical relating is elaborated as part of her work on animals as companion species. My interest lies in another relational figure, one invoked by DIYbio members; meaning 'the people,' the 'everyone,' or the generic and anonymous 'you.' The project of a personal biology is deeply entangled in this multi-faceted entity. In this sense, I try to understand the production of a code of ethics as a discursive attempt to relate to the abstract category of 'the people,' as a sort of otherness-in-relation that DIYbio members are constantly claiming to empower. Therefore 'the people' can also be considered as a legitimizing entity DIYbio member's project are aimed at.

For this chapter, my approach focuses on a detailed description of the DIYbio European Congress, hosted at the London School of Economics, in May 2011. The event, the first of two 'coding' sessions, was aimed at establishing a code of ethics for the portion of the DIYbio network located in Europe. At the very beginning of my field work, I remembered my expectations of attending the event. Despite my increasingly sceptical attitude towards DIYbio's discourses and practices, I hoped to witness, if not participate in, a courageous and collective elaboration of moral and political judgements on what it means to be a young and/or disenfranchised life scientist under the experience of contemporary neoliberalism. To my surprise and discomfort I found myself part of a visionary workshop where the writing of a code of ethics was presented as a process and performed through fragmented conversations mediated by post-it notes. It was out of this discomfort that I decided to focus on the notion of ethics as a process. Additionally, the more I engaged with my fieldwork material, the more I felt uncomfortable with my own writing. I felt stuck in the search of a comfort zone between a descriptive register and an abstract criticism of the DIYbio network. Slowly, I began to learn the extent to which the material constantly addressed my limited experience and partial understanding of my own political consciousness and moral commitment as a person trained in the life sciences. A person who, as other DIYbio members had, had dropped out, instead drifting towards the critical promise of the social sciences

rather than towards that of a personal biology.

In doing so my aim is not to offer a normative critique on how the code was an exercise in public relations or perception management aimed at, as one of the organizers put it, carving a legitimate space for the socio-technical vision of a personal biology. Instead, my effort goes into remaining suspicious but engaged by attempting to offer a number of careful *contradictions* about the difficulties of thinking beyond our experiences of what we might find problematic, normal, appropriate or desirable as (mostly) young individuals trained in science and technology disciplines.

With the term contradiction I do not refer to the production of rational oppositional claims. What I am searching for is a discursive practice that acknowledges my interlocutors' sense of 'meaning well,' in terms of the way they have come to experience the imperative of being 'useful' and 'helpful' via the specific act of providing 'technological solutions,' in present times where techno-scientific progress is both acutely contested by members of the public and at the core of our societies' economy. If an important number of DIYbio members feels disenfranchised from mainstream life science research, my wish is to take their feelings seriously, while at the same time questioning in which way a personal biology is supposed to be an alternative. The capacity of becoming conscious of the embodied values in what we think of as 'alternatives,' I argue, is deeply experiential and intimately related to our always partial understanding of 'the others' (or others).

To allow the space for what became a more considerate writing, I decided to focus on only one of the two coding events. As I had lost my fieldwork notes for the second coding event, I relied on the notes taken by one of the organiser's colleagues. If these notes were useful, and even comforting in the beginning, as I was writing in a 'detached manner,' I came to realize that, in them, participants' emotions or reactions were not documented, and that I could not therefore use them. For this reason, I returned to describing the first coding event only based on my field work observations, interviews with the organizers, and the documents kindly provided by them.

In the first snapshot I dedicate quite a long section to describing the preparatory phase of the coding event. My reason for doing this is to trace the sophisticated negotiations that made the two coding events possible. In particular,

the involvement of influential think tanks, scholars, and the design of the coding event as a visionary participatory workshop, but also the role of one of the co-founders as a community organizer. In the second snapshot I retrace the steps in the proceeding of the coding event by paying particular attention to the relations between ethics as a process and the emotions in the room, including my own. In the concluding section, I argue that when looking at social groups that are mainly recognized for their technological practices, it is necessary to move from descriptions of the politics of these practices, to also including the practice of policy making that the actors engage in.

First snapshot – Networking moral aspirations

In 2011, David Rajeski, the Director of the Science and Technology Innovation Program (STIP) at the Woodrow Wilson International Center for Scholars (WWC) in Washington D.C, and Ph.D. Todd Kuiken, a senior research associate working for the Synthetic Biology Project (part of STIP) were invited to attend 'Outlaw biology? Public participation in the Age of Big Bio.' The symposium, aimed at exploring new forms of public participation and of biological and engineering research beyond the university and the corporation,[1] was organized by the University of California Los Angeles (UCLA) Center for Society and Genetics in collaboration with the UCLA Art| Sci Center. The event brought together the founders and early members of the DIYbio network, other representatives of a so-called 'outlaw biology,' FBI agents, academics, artists and members of the public. In our interview, Kuiken recalled that back in 2011, he and Rajeski knew very little about the DIYbio network, and that it was by attending the 'outlaw biology' conference that 'it clicked.' As I was interested in his role as an employee of a leading American think tank[2], and later the co-ordinator of the

1 Paraphrased from <http://artsci.ucla.edu/?q=events/outlaw-biology-public-participation-age-big-bio>. Last accessed 25 May 2014. These modes of public participation were listed as: DIY biology, molecular cooking, Nano Hacking, At-home Chemical research, Recreational Genetics, Synthetic Biology, Open Source Science and Bioart. Available at: http://outlawbiology.net/. Last accessed 24 March 2012.

2 The Woodrow Wilson Center for Scholars defines itself as a non-partisan think tank located in Washington D.C, whose main vocation is to inform policy making through the production of expertise across a broad set of domains: disaster management, gender and inequalities, international development, security and defence etc. The collaboration with the DIYbio network, was part of the Technology Innovation Program and its arm dedicated to synthetic biology. The program's aim is minimize the risk and maximize the benefits related to the development of synthetic biology. As part of this program the DIYbio was recognized as an area of interest for the think tank.

collaboration with the DIYbio network, I asked him in which way the WWC was interested in collaborating. Kuiken explained that for them the DIYbio network represented:

> An opportunity to get people to be excited about science again particularly in the States, for instance there is not a lot of public education at the high school and middle school at all as far as biotechnology is concerned, and probably there is very little and so also as a way to get people excited about that before they get into college. And then of course there is the sort of larger societal aspect, you know the comparison to the Apple computer having been developed in a garage and so there were all these different sides attached to the DIYbio movement as well […].

Expressing that the implications of a Do-It-Yourself biology were different from other hobbies such as chemistry, he continued by specifying that he felt they could help with' the environment, health and safety side of it.' I further questioned him about what characterised the role of the WWC as a helper. Kuiken explained to me that an early goal was to introduce DIYbio to 'D.C,' referring to the policy making community in Washington D.C. Furthermore, in his opinion the WWC's political tradition and funding structure gave the think tank a unique position which 'enables us to bring all of the players together into the room, with no fear of retribution.' Kuiken also took some pride in pointing out that at the WWC, policy makers, private sectors representative and radical activists could sit at the same table.

Two months after the conference, Jason Bobe, DIYbio co-founder, was invited to the WWC's headquarters in Washington D.C to present the network at one of the regular seminar series organised by the think tank. It was at this occasion that he asked the attendees: 'how do we build a positive culture around using technology and become good biocitizens?'[3] The question cited at the beginning of the chapter. In our interview I asked Bobe about the seminar and asked him to describe how he understood his role as the 'policy maker' of the DIYbio network.[4] He recalled that:

3 Simply entitled 'Biosecurity,' the event was advertised as providing an opportunity to debate how the promise of a biology easier to engineer and the emergence of a community of amateur biologists was provoking new biosecurity questions and challenges. The other speaker was FBI Special Agent Edward You, head of the Synthetic Biology Outreach program. A video recording of the event is available at: <http://www.wilsoncenter.org/event/biosecurity>. Last accessed 11 July 2012. For the relation between the members of the DIYbio network and the FBI see Aguiton and Tocchetti (forthcoming).

4 In this chapter I focus on Bobe as the policy maker, but with the progressive development of the network other regional spokes-persons have similarly routinely engaged with representative of

> When I went to the WWC [...] there were people from all agencies, from the government there and at the end I say 'hey look I need your help' you know there are all sorts of agencies that range from environmental issues to policy issues that really need an effort to work together around these things and if you have interest in this, you know, reach out to me, I would love to hear your ideas and figure out how to work together and I think from there it sort of catalyses my role for the policy community to get me more invites to these things, and so after that it came the Presidential Commission, you know, all these talks are very similar […].

Bobe reached out for help by inviting the representatives of different governmental agencies in the audience to collaborate on a variety of environmental and policy issues. He also suggested that his call for help might have played a role in his eventually being invited to other similar events such as the synthetic biology's review from the The Presidential Commission for the Study of Bioethical Issues[5]. About his role as the 'policy maker' of the DIYbio network, Bobe further explained:

> [...]There was a particular comment at one point where, you know, when someone on the board [DIYbio Google Group] was like 'can we please take the policy discussion to another board, we are here to talk about the technical stuffs' and you know, I found that discouraging for the community because it is not like if, I felt like that some in the community were really naïve to think that there was no role for policy in this [laughing] and if you put the head in the sand like that you are going to be buried and have to engage and you have to deal with the issues and is not going to be easy and I am always taking my neck out on the discussion list and it's something that I actually had to be careful about a little bit because I didn't wanted to just being a squeaky wheel who was talking about policy issues, I wanted to introduce them when they came up, I wanted to engage with them [the members of the network].

Bobe recalled a particular comment making him aware of the naivety of some members, for whom policy discussion and 'technical stuffs' were to be addressed on

regulatory agencies, bioethics commissions and think tanks.

5 Following David Rajeski's suggestion the commission invited Bobe to present the DIYbio network. In the report DIYbio is mentioned in a brief paragraph entitled 'Fostering Grassroots Collaborations.' In it, DIYbio members are presented as "self-described 'citizen scientists.'" The report concluded that 'these kinds of collaborations are commendable; they strengthen notions of citizenship and community at the core of a democracy. […] A community- oriented perspective strengthens efforts to ensure that this science develops in ways that will be acceptable to the majority of the population. This perspective also complements activities intended to promote justice and fairness in the development of synthetic biology and its applications' (PCSBI, 2010).

different discussions forums. He described his role as the one who carefully 'stuck the neck out' in order for the DIYbio network not to be buried in the sand. He concluded by stressing his desire to engage DIYbio members about policy issues.

The aims of the collaboration between the WWC and Jason Bobe as representative of the DIYbio network were to: i) pursue the work on the DIYbio.org website, described as an effort to make the community transparent; ii) establish biosafety and user-friendly guidelines and iii) to develop codes of conduct/ethics.[6] In June 2010 the collaboration was consolidated via the financial support from the Sloan Foundation[7], and Bobe, partly paid by the grant, begun organizing the two 'coding events.' Bobe further explained to me that from the beginning:

> there was also the recognition that this code, even if I am on the inside of the community, is not something that I can sit down and write, and 'hey here is the DIYbio code' it had to be a participatory process and I loved workshops where you get a small number of people together and you know you have some goals and you spend the day thinking about it.

In this quote Bobe expressed his concern for the process to be participatory and not imposed by him. He further described such process as a workshop gathering a small number of people, which under some established goals spend a limited amount of time thinking about the code. I asked him to explain more about the type of workshops he was referring to, and he continued:

> I always really liked the sort of visioning workshops and that process of sort of structured productivity or structured creativity and structured collaboration and always wanted to grow those skills and so this congress was an opportunity for me to work with Noah professionally [Noah Flower, see next paragraph] […] and you know because we were dealing with some constraints and one of the constraints is 'hey look we got one day, you know, we got one day to make it happen, we have very little resources here, and if we made in three days then we could have a day of conversation, you know, but we really have to be really focused on process and generate something, and this is like a constitution it's not set in stone it's going to change, and I hope that people adopt it and [single inaudible word] it and that was the whole point, make their own version.

6 From the summary of the coding event that Noah Flower kindly shared with me.

7 The Sloan Foundation is an influential organization promoting national science and technology: 'The Foundation makes grants to support original research and broad-based education related to science, technology, and economic performance; and to improve the quality of American life.' Available at <http://www.sloan.org/about-the-foundation/>. Last accessed 31 May 2014.

Bobe described his interest in 'visioning workshops' as a place where he experienced the process of structured productivity, creativity and collaboration. He also recalled his concern in having to work with limited time and financial resources. These constraints, in his opinion, required the conversation to be focused on process and productive. At the same, time Bobe expressed being aware that the output was not 'set in stone,' as he hoped that other members of the DIYbio workshop would make their own version of the code.

Bobe, told me that he was first exposed to 'visioning workshops' while working in San Francisco. Back then he participated in several events organized by leading techno utopian think tanks and organizations such as the Institute of the Future[8], the Long Now Foundation[9] and the Global Business Network (GBN)[10]. There, he met Noah Flower, a graduate in moral philosophy and an experienced Research Analyst at the Monitor Institute, another leading Californian think tank and part of the GBN. They became friends and Bobe invited Flower to facilitate both events. As part of our interview, I asked Flower what the DIYbio network represented for him. Mentioning that he relied on information received from Bobe, Flower told me that the DIYbio network was a

> group of amateur experimenters who wanted to find a way to legitimize the practice of biology by non-scientists and outside academia, and wanted to organize this community that was emerging on its own around the world.

He concluded by explaining that a part of such organizational work demanded that they 'carve out a legitimate legal, and socially and politically acceptable space for it, in

8 The Institute for the Future is a spin-off from the RAND Corporation, one of the most influential post-World War II military planning groups (Medvetz, 2012). The Institute combines the vision of computer network as instruments of group communication and social sciences methodologies which give to 'the Institute a unique voice in the world of technology and laid the foundation for social assessment of technologies at the individual, household, organizational, and societal level.' Available at <http://www.iftf.org/fileadmin/user_upload/images/whoweare/iftf_history_lg.gif>. Last accessed 11 July 2012.

9 The Long Now Foundation 'was established in 01996 to creatively foster long-term thinking and responsibility in the framework of the next 10,000 years.' Its founders include techno-utopianists Stewart Brand, the founder of the Whole Earth Catalog (see chapter Three) and Kevin Kelly, one of the founders of Wired Magazine. Available at <http://longnow.org/>. Last accessed 12 July 2012.

10 The Global Business Network was founded in the late 1980s as a corporate consulting firm. Its most prominent figures Stewart Brand and Peter Schwartz, the head of the Planning Group at Royal Dutch/Shell, infused the network with a 'particular blending of countercultural and techno-cultural organizational styles' (Turner, 2006a: 184) in particular cybernetic theory and the countercultural critique of hierarchy, as well as collaborative work styles from cold war research institutions. Scenario-planning sessions where a common thinking technology used in the meetings of the GBN (Turner, 2006a: 181-194).

society.' Flower continued by justifying that the necessity of organizing the DIYbio network was a consequence of the inevitable development of technological forces, stating that 'the technology was making it so easy that it was going to happen one way or another and the goal of DIYbio was to find a way for this to happen, to sort of channel it into its highest and best use.' As part of his role as a facilitator Flower explained that the expertise he brought to the workshop was scenario planning, and more generally helping people to think about the future in terms of changes and organisational adaptation.

Flower's discourse is marked by the belief that a biotechnology available to all is bound to happen. He described the DIYbio network both as a community emerging on its own, and as an organisational attempt to channel such inevitable technological development into its highest and best use. A participatory process that Flower, as a friend of Bobe, but especially as a professional analyst in an influential Californian think tank is invited to 'facilitate.'

In organizing the events, and to avoid having to 'start from scratch' Bobe established an inventory of codes of ethical conduct. This was a search that he mentioned being inspired in part by 'hacker ethics' but mostly by the amateur radio community, other amateurs and also professional codes of conduct. In doing this, Bobe studied how principles where phrased and selected a number of examples he thought relevant as background material for the participants of the coding event. Bobe's research resulted in the production of the 'Background material for the DIYbio continental Congress.' In it the putative purpose of a code for the DIYbio network was presented:

> The development and adoption of a code may help foster norms and establish minimal ethical standards. As new practitioners join the community, individual and collective responsibilities and establish a code may function to clarify a common set of considerations for reflections. For outsiders' suspicious of DIYbio or biohacking more generally, a code may help foster public trust. The coding process can serve to raise awareness about important issues, stimulate discussions and achieve educational goals. Others have seen the process of coding to be even more beneficial for norm development than any particular code itself, an insight captured in the phrase 'a code is nothing, coding is everything' (DIYbio, 2011:3).

In comparison with the enthusiasm reflected in DIYbio's members PowerPoint

presentations and blogs entries, this statement is marked by repetitive use of the conditional. In a sense, the paragraph simply reiterates a number of common aspirations associated with the establishment of codes of ethics in the scientific professions, such as the possibility to establish norms and 'minimal ethical standards,' and to promote 'public trust.' Additionally, as there is no formal membership to the DIYbio network but only to the regional community laboratories, the code is also presented as a tool aimed at clarifying a common 'set of considerations,' which remained vague. The term 'coding process,' where coding, as for other terms adopted by DIYbio members, playfully refers to the gesture of writing computer code, is used to highlight the importance of the process over the result. As the term 'process' entails the idea of something moving forward, the following of a succession of programmatic steps leading to an expected result, I was sceptical but intrigued at its use in the context of ethics. Something that I understand as an experience where in doing and undoing relations, we deeply engage with the partial meaning and values of our individual and collective actions. More specifically, in the document, the term was used in reference to Brian Rappert's paper 'Towards a Life Science Code: Countering the Threats from Biological Weapons' (2004). Rappert, a British academic, was one of the experts Bobe sought advice from during the preparatory phase. In the cited paper, Rappert aligns him self to the social scientists, particularly the ones in the field of business ethics, who critique the evaluation of codes in terms of their impact and effectiveness. This critique stresses the importance of

> the process associated with devising and revising codes. The phrase 'a code is nothing, coding is everything' has been used to highlight the procedural aspects. Particularly with regard to the educational aim of raising awareness, posing the issue of what constitutes appropriate conduct through a process of devising a code can have many benefits (2004: 21).

These benefits are briefly described in terms of the positive virtues of ambiguity and uncertainty to draw attention to the limits of the code as a tool to set standards, therefore privileging dynamic processes over static statements. Rappert further explains that

> What is needed instead is a process of formulating codes that is fairly explicit about its presumptions and that seeks to engage a wide range of participants over time. Initial disagreement might well prove productive in terms of achieving a more effective code in the long term and also suggesting alternative

possibilities (2004: 21).

My interest in the difference between ethics as a process and as a relation grew out of the assimilation of this discourse by the organizers as part of a visionary workshop.

This preparatory work was followed by an invitation to the two congresses, sent out on different mailing lists and posted on the DIYbio.org website. The organizers[11] asked each 'active regional DIYbio group' to 'nominate one or two delegates.' Delegates were asked to read the 'Background Materials,' prepare a short presentation describing their project or local group's activities, respond to a brief online survey and to report back to their local groups. In the survey, participants were asked to elaborate three statements they strongly felt should be included in the code, their 'top three hopes,' 'top three fears' and the 'top opportunities and risks' concerning their regional groups. Lastly, out of a collaboration between Bobe and Alex Hamilton, a colleague and PhD Student at the London School of Economics doing research on synthetic biology and biosecurity, the decision was taken to hold the DIYbio European Congress on campus.[12]

The use of terms such as 'congress' and the nomination of 'delegates,' but also the designation of the DIYbio.org as a 'network of networks' reflects a language giving legitimacy to the event. Similarly, by being hosted at the London School of Economics, the institutional legitimacy and expertise gained from collaborating with think tanks is doubled by the prestige of the commodified culture of intellectual leadership the school is renowned for. Lastly, the use of a survey reflects a common curatorial practice within the DIYbio network.[13]

By tracing this laborious preparatory phase the aim of this first snapshot is to illustrate how, the writing of a code of ethics was framed. Especially, how out of this meticulous preparatory phase, Bobe emerged, at least temporally, as the person of reference for policy issues. The one that, as he put it, took the risk of being perceived as the dysfunctional wheel slowing DIYbio's race. In doing this, Bobe, whose professional position is as a 'director of community,' knit together several actors

11 Hereafter I will use the term to refer to the role that Jason Bobe, Todd Kuicken, and Noah Flower interchangeably took during the coding event in London. By doing so my intention is to mark their actions as different from those of the participants.

12 The DIYbio Continental Congress was hosted instead at the headquarters of the Monitor Group, in San Francisco.

13 Regularly circulated on the DIYbio Google Group, surveys have been used by co-founders to gather opinions on collective aims, by members to understand others members needs, and mostly by externals (think tank analysts, journalists and scholars) as a method to gather data on the members of the online network.

belonging to previously unrelated social groups. These include members of influential think tanks and scholars: the Woodrow Wilson Center, who sees in DIYbio an opportunity to promote science education; the Sloan Foundation providing financial support; an experienced analyst from Monitor 360, who brought scenario-planning to the group and strategies for the network's members to think about the future in terms of changes and organisational adaptation; and a scholar working in the field of biosecurity, whose writing inspired Bobe to consider the production of a code of ethics as a process rather than something to be evaluated in terms of its impact. In taking care of this work, I argue, Bobe demonstrated that, as for the making of web content, the organization of public demonstrations, or the setting up of community and individual laboratories, policy making becomes just another 'making' that the DIYbio network need in order to thrive. More specifically ethics as a process took the form of a visionary workshop. The gathering imagined by Bobe and Flower was designed as as a participatory process; one where structured productivity, creativity and collaboration can take place with a reduced amount of time and resources. Such participatory process begins with the designation of delegates, a term used to designate the participants, but more importantly it begins with the collection of participant's individual opinions online. In the next section I focus on the coding event in London, and describe the enactment of ethics as a process by paying particular attention to the relations between ethics as a process and the emotions in the room, including my own.

Second snapshot – The code is nothing, coding is everything

In the London School of Economics' oldest building, at the centre of a wide seminar room, several small tables were brought together. Numerous pens, whiteboard markers, and blocks of multi coloured sticky notes were scattered on their surfaces. Five large white boards were positioned at the table's left side, an additional sticky flip-chart pad was available and the beamer was in operation. On the wall in front of the delegate's table, a large sheet of white paper waited for Nick Payne, a 'graphic recorder'[14] paid to draw the discussion. On the other side of the room, a smaller table was provided for the 'observers:' two fellow researchers from the BIOS Center[15], Todd

14 In common language a 'graphic recorder' is an 'instrument in which a signal driven pen or stylus makes a permanent record of a quantity on graph paper.' Available on <http://www.doctionaryofelectronics.come/graphic-recorder.html> last accesses 27th July 2013. Since the 1977, the term has also been used, to refer to the practice of facilitating meetings trough graphical means.

15 The BIOS Centre for the Study of Bioscience, Biomedicine, Biotechnology and Society was an

Kuiken from the WWC, and myself. Coffees, teas and biscuits were served.

As the delegates entered the room, they shook each others' hands warmly. Only few seemed to actually recognized each other, while most looked simply pleased or surprised to be able to put a face to a user name they had seen or written to on the DIYbio Google Group, the network's main mailing list. With the grant from the Sloan Foundation the organizer managed to partially cover the travel costs of thirteen participants coming from different European countries[16]. The composition of this group reflected the socio-professional demography of my research sample: Ph.D. students and master students in synthetic biology, molecular biology, biomedical sciences (7) or computer science (2), most of whom had participated in iGEM, a graduate from Interactive Digital Media (1), a student in medicine (1), a web developer (1), and a Ph.D. in biotechnology turned art and science practitioner.

The event was for them a uniquely affordable occasion to meet off line. As planned in Flower and Bobe's notes, the morning was aimed at 'breaking the ice.' Bobe welcomed everyone to a congress 'gathering the grassroots leaders of the movement' and started the day with a PowerPoint presentation. Surprisingly, the first part provided the audience – composed of DIYbio members – with a definition of what is the DIYbio networks, the 'state of the community' and its most iconic projects and influential members. Bobe customized his talk by stressing five additional points. In an analogy with the radically distinct modes of regulation in amateur model rocketry (rather loose) and power rocketry communities (strict oversight), he argued that defining which activities and whose actors belonged to the DIYbio movement was crucial. He also stressed the importance of establishing a code at the early stage of the community, in order that members would comply with it, but also the necessity 'to have a coherent answer to give to media.' Bobe exemplified such concern by showing some of the alarming headlines from the mainstream media. As planned with Flower, Bobe also presented a 'cautionary tale' aimed at illustrating why the code 'should address some of the concerns of the public.' The story concerned the role of two civil associations in leading the opposition to the construction of a biosafety level four laboratory in Boston. An example, Bobe claimed, that illustrated how 'the public can

international centre for for research and policy on social aspects of the life sciences and biomedicine established in 2002 by Nikolas Rose. It was closed in 2011.

16 Respectively: Paris (3), Manchester (3), Newcastle (1), Cork (1), Berlin and Freiburg (3), Copenhagen(1) and London (1).

be really afraid of biology, fear of biology need to be thought through.' He concluded by reminding participants of the aspirational and participatory nature of the discussions, inviting the them to 'give it the best shot.'

While no-one commented or questioned Bobe's presentation, I wrote 'what??' near the notes on Bobe's cautionary tale. As I read my transcripts, I still feel hostile to his cautionary tale, portraying a public afraid of biology; when actually the example he used referred to the democratic deliberation over the construction of a biosafety level four laboratory (King, 2008).

It would be difficult not to agree with the alarmist tone of the headlines used by mainstream media, but Bobe's claim that DIYbio members should be the ones providing coherent answers, seemed equally overstated. DIYbio members very often used the similarly overblown rhetoric of techno scientific promises as a persuasive tool to attract the interest of the media, members and revenue. It is at this point that I began to take seriously the emotions in the room, including my own, both the one scribbled down during the event and the one I experienced while reading my transcripts afterwards.

Clustering hopes and fears to establish common concerns

Eager delegates then introduced their projects regularly exceeding the assigned time. They enthusiastically described their work: how their cleverly acquired laboratory equipment, what type of activities they begun with, who attended them, etc. Few participants echoed expectations similar to Bobe's. Only one delegate proposed combining the 'trust structures' in social networks and laboratory audits to establish a 'couch surfing system'[17] where members with laboratories could rotate, 'auditing each others laboratories' by visiting them with 'external experts.' His proposition was judged too ambitious, and after a brief and awkward silence the discussion moved on. In the meantime, Flower and Kuiken set up a 'foresight exercise.' On the white board they wrote in big blue letters FEARS and HOPES in red. First they grouped the survey answers into clusters, then titled them placing them under the emotion and foresight categories, FEARS or HOPES. Lastly, they affixed the clustered sticky notes (green for fears and pink for hopes) where they had previously hand copied all the surveys' answers. As the time dedicated to the delegates' presentations exceeded the planned

17 Available at <http://p2pfoundation.net/CouchSurfing>. Last accessed 12 June 2012.

slot, Flowers professionally interrupted the discussion. He introduced himself, and spoke about the strategic advantages of thinking in terms of possible futures, as a way to 'track trajectories,' 'establish incentives' and 'narratives' and an efficient way to prepare for the afternoon. Flower explained that the aim of the 'foresight exercise' was to help the participants achieve an understanding of each others' perspectives both when overlapping or diverging, noticing that divergence was not to be considered a problem. After describing how they clustered the participants' answers, Flower gave each of them three adhesive dots and, invited them to stand up and stick their dots onto the most relevant hopes and fears, but excluding their own.

Figure 5.1 Fears and hopes.

Participants were asked to choose three fears and three hopes from those collected during the survey. Here a snapshot of the white board. For HOPES, 'Have fun enjoying the wonders of biology for art, gastronomy, and science' received the highest score of six dots. For FEARS, 'General public conducting experiments without proper safety equipment due to lack of knowledge' receiving the highest score of five dots.

A first cluster of hopes was strongly marked by the theme of innovation. Delegates expressed their hopes of being capable to gather people from different backgrounds interested in science to 'spark off ideas and projects that wouldn’t have happened otherwise,' or providing a 'break with knowledge monopolies.' A sub-theme of the same cluster was marked by the hope of producing 'valuable solutions to serious world problems' that larger institutional science failed to provide 'due to investments or conflict-of-interest concerns.' Additionally, during the voting exercise, 'Have fun

enjoying the wonders of biology for art, gastronomy, and science' received the highest score of six dots. For the European delegates, the second major cluster of hope expressed concerns about the group's capacity to educate 'the public,' 'non-scientists' or 'naturally curious people' about biotechnology and, by doing so to 'democratize science.' Delegates also expressed their hope of promoting 'reasoned public debate' and a 'critically-minded hands-on approach to biology and biotechnology.' These hopes were also understood as an opportunity to establish a culture of sharing; curiosity, hands-on activities and creativity that would develop a 'personal relationship to science.' A last cluster was composed of two seemingly incompatible answers. One expressed the hope of establishing a critical position towards 'biotechnology,' the other to enthusiastically promote 'biotechnology.'

The delegate's major cluster of fears concerned the misrepresentation of their activities. They expressed these fears in term of 'misunderstanding from the general public' and of 'public backlash.' Additionally, the vote taken during the event showed that participants were particularly concerned by the possibility that 'the general public' might perform dangerous experiments. Participants expressed these fears in term of 'slanted misinformation from the mass media' or to the conflation of their initiatives with the 'public backlash against Genetic Modification.' A second cluster was marked by the fear that practitioners might endanger themselves or the environment, by releasing organisms or toxic compounds. A third cluster concerned regulation. In particular, delegates expressed the fear of 'knee-jerk regulation by those who don't understand (or are unwilling to understand) its potential,' or, similarly the killing of knowledge sharing by bureaucracy. Finally, a fourth and minor cluster expressed fears of losing the cultural integrity of the group due to commercial interests or pundits taking over the group.

While following the conversations, I scribbled down a comment on the choice of hopes and fears as the emotional starting points of an ethics for the DIYbio network. I read this choice in resonance with Haraway's analysis of secularized discourses of salvation and apocalypse in technoscience. Haraway argues that not only the promise of a 'cure for the trouble,' justifies the sacred status of the deceptively rational scientists, but also that it feeds the belief in impending disasters, thus 'the impossibility of ordinary materialization is intrinsic to the potency of the promise' (Haraway, 1997:

41). In the example of the DIYbio European Congress, on the one hand, there are the hopes that the socio-technical vision of a personal biology would produce the type of innovation dismissed by the increasingly profit oriented agenda of science, but also the one that such endeavour would be embraced by the public as promoting reasoned public debates and more generally a personal relationship to science. On the other hand, the fear of misunderstanding, caused by mass media misinformation, public backlash, stringent regulation but also the co-opting of the group by commercial interests. What strikes me here, is that secularized discourses of salvation and apocalypse in technoscience seem to have become a relational tool aimed at establishing common understanding and organizational trajectories among members of a group who on the whole do not know each other.

Flower later explained to me that fears and hopes are simple questions that almost everybody is capable of answering, and that therefore are a useful tool in order to think about the future. He also specified that, used alone, they are not an accurate method for scenario planning, but in the context they were useful in establishing a common understanding among participants of the network's goals.

When read in conjunction with the remixed trope of scientific revolution as captured by the iconography of DIYbio's poster (see Chapter Two), theirs hopes and fears seem to leave little space for other emotions and other relations. More specifically, I wondered what type of common understanding could be built by clustering fears and hopes for the realization of a socio-technical vision among a group of people whose members are mostly meeting for the first time?

Again, in my notes, a fragmented comment reads 'other emotions??' For instance what about sadness, trust, serenity, or outrage? In which sense are these less relevant to the establishment of a common understanding and organizational trajectories within a group of mostly young scientists? What about the feeling of uncertainty, of partial understanding and doubts about what it means to define a different practice of science? Or the emotions about being part of the DIYbio network in the first place? Which emotions comes with the promise of a personal biology, and how do these inhabit the present of DIYbio's members as defined by a much broader set of preoccupations and desires? To answer these questions, I try to connect Haraway's critique of secularized discourses of salvation and apocalypse in technoscience in a context where they become tools to establish common concerns, to

her notion of an ethical relating, one striving for an 'ongoing alertness to otherness-in-relation.' I wonder, what types of otherness-in -relation one can experience within the narrow space delimited by hopes and fears used as tools to establish common concerns, especially within a group of mostly young scientists who do not know each other and who repeatedly voiced their sincere commitment to empower 'the people' through a more personal relation to biology and biotechnology.

Meanwhile, keeping track of the time, Flower invited the participants to explain their choices. The discussion was quickly monopolized by a minority of delegates both fluent in English and in the art of oration. While they limited themselves to reiterating the themes already expressed in the survey, it was striking to notice how disjointed the discussion was. Without expressing agreement or disagreement with the previous comment, delegates eagerly piled their point of view on the top of the previous one. The discussion quickly turned to their major hopes of achieving their respective projects. As they begun talking about the problems they faced, mutually suggesting solutions or practical help, again, Flowers intervened reminding them of the aim of the day. He proposed repeating the exercise, this time by comparing each others' fears and hopes. Again, the most at ease took the floor, though this time they expressed shorter remarks, such as 'I don't understand what is the use of this!' voicing their scepticism toward the exercise, as well as the practical purpose of the code. As their concerns were heard and commented upon by other members, the hour for the foresight exercises passed. Claiming that the presentation from Brian Rappert – the expert in professional science's codes – might provide some relief to the participants' doubts, and aware of the delay accumulated, the facilitator proposed continuing by having lunch while listening to the expert's talk and by having a shorter break after.

This passage reminded me that most of the participants did not speak fluent English. But it mostly made me attentive to the awkwardness of talking in front of individuals one has just met, and with whom one is supposedly committed to a similar, yet still to be defined, socio-technical vision. It is in this was that I read the piling up of delegate's opinions. An awkwardness that only seemed to dissipate when the subject discussed was the actualization of participants' major hope (i.e the realization of their socio technical vision) with participants eagerly describing their problems and helping each other with advice from their personal experience. This moment was interrupted by

Flower, whose professional interventions nonetheless framed the participatory process of 'breaking the ice.' Additionally, rather than taking delegates' scepticism seriously as a meaningful, although potentially disruptive emotion to be shared and discussed; the facilitator steered the group in the direction set by the organisers (i.e producing a code of ethics for the DIYbio network in one day). As part of this gesture, Flower also put the expert in the position of the one having 'the answers.' As they moved to the next step the undercurrent of emotions in the room were gently swept aside by the facilitator, while on the whiteboards the surveyed emotions written on the post-it remained visible.

Missing the reflexive moment?

The first part of Rappert's presentation focused on describing and distinguishing the purposes of different types of codes (i.e aspirational, educational and enforceable). In the second and longest part, Rappert presented the sociological critique of scientific codes, highlighting the importance of the process over the evaluation of the code's impact (see first snapshot). As Rappert's presentation questioned the specific politics of regulation that codes of ethics promotes and its evaluation in terms of effectiveness, he did not comply with the expected role of advising the participants on how to write a successful code, nor did he offer any relief to participants' doubts about the meaning of the event. Contrary to the effect hoped by the organisers, at the end of Rappert's talk the delegates looked even more confused and discouraged. In an attempt to maintain their enthusiasm the organisers asked them to raise their hands if they were in favour of writing a code. All raised their hands. But the unanimous vote sparked a discussion about the legitimacy of the code and of the gathering. A delegate reminded the group that 'not all were there.' Another questioned if the subscription to the code should be manifested by signing it. Signing was vociferously rejected by a majority of the participants on the ground that anonymity should be guaranteed in the event that some DIYbio members might live in authoritarian regimes. Responding to the question concerning the representativeness of the gathering, another participant argued that they nonetheless 'knew more than the rest of the community.' A last concluded that despite these differences the code should not contain expressions such as 'good' or 'bad,' but instead should insist on 'respect,' as in the case of nature. The discussion moved on to the recurrent theme of how difficult is to define what DIYBio is and how without

definitions it was not possible to determine principles for conduct. Another delegate argued that instead it depended who was the recipient of the code, and that it should be written in a simple and non-intimidating way.

In his role as an expert, Rappert politely avoided giving the participants a ready made recipe, or a kit to make a code of ethics. The participants, instead of taking the opportunity to tinker with what it means to establish a code of ethics as part of a socio-technical vision sustained by a desire to reform certain aspects of mainstream science, ended up confused and discouraged. Triggered by the expert's 'non-action,' this emotional blockage created a moment of uncertainty in the sequential process. Another potentially disruptive moment that, once more, was not taken up. Instead, as a process, ethics in-the-making remained driven by the production of a code. The organisers guided by the imperative of maintaining the group at work did not recognize that participants' confusion and discouragement might trigger a reflexive moment. What could have become an occasion for the participants to figure out the problem with ethics is as a mainstream institutionalized discourse, was dissipated into the gesture of voting as a unifying moment. The vote, called upon by the organizers, reminded the participants that the making of the code was a common goal to which the success of the DIYbio network was entangled with. But the symbolic consensus was followed by further uncertainties. In particular, participants voiced their doubts about whose moral principles the code was supposed to represent; what sort of restrictions the code should highlight, and how these doubts were tied to the recurrent uncertainties concerning the definition of DIYbio. As the establishment of definitions rarely bring ready-made consensus, and often trigger secessions, the facilitator moved the proceeding swiftly on.

In the meantime, regardless of the ongoing discussion, Kuiken and Flower were setting up the next phase, displaying on the whiteboard the new sticky notes. On them delegates' responses to the survey' questions 'What are your top three statements you feel strongly about including in a DIYbio code' had been written. As the organisers seemed ready to move on, Flower professionally interrupted the discussion but, Brian Rappert, echoing one of the delegates, proposed instead that participants should answer two other questions: 'for whom they were writing the code and why writing a code at all?' The organisers and the participants agreed on Rappert's reflexive proposition. The participant's uncertainty, this time under the direction explicitly

framed by Rappert's questions, become productive, and therefore, once more, acceptable. The sticky notes were displaced, the two questions written on the whiteboard, and rose and orange sticky notes were distributed. Delegates were given ten minutes. Progressively they stood up, affixed the notes and read each others answers. Once they had all finished, Flower invited them to gather by the white board, where he clustered the answers by summarizing the major themes and highlighting similarities and differences.

Figure 5.2 Gathering around the clusters

The participant reading each others answers, and the answers as clustered by the facilitator.

In response to the question of 'Why write a code at all?' a first cluster was marked by some frustration epitomized by the comment 'TIRED OF DEFENDING AND DEFINING WHAT CAN I DO? I WANT TO START PLAY.' The discussion of a code is understood as annoyingly postponing the playful act of doing. In the same cluster another wrote 'Demonstrate that DIYbio should be legitimate without need for strict over regulation.' Flower acknowledged these concerns and moved to the a second major cluster. Organized around the idea of 'raising awareness' the cluster's theme is ambiguous as its formulations refers both at the members of the DIYbio network, as well as as the member of 'the public. Again Flower described their contribution and

moved on to another major cluster marked by the concern that the code should facilitate the communication with the media and more generally being “A 'shop-front' for DIYbio.” Finally, Flower briefly summarized a last cluster marked by a long commentary from a participant who described the importance of agreeing on rules that are bounded to the work with sensitive technologies.

Figure 5.3 Who is the audience?

The answers as clustered by the facilitator, and the priority list of for who is the code.

By comparison the sticky notes displaying the answer to the question 'Who is the audience?' contained, to the exception of one long one, briefer comments. What the clustering suggests is that a majority of the delegates designated the Media and the public as its principal audience. The 'community,' new members' and 'ourselves' appears only in a minority of the sticky notes. These priorities were reinstated by the list summarizing in big letters: MEDIA/ THE PUBLIC/ THE COMMUNITY/ NEW COMERS/ GOVERNMENTS (see Figure 5.3). In the long comment, a delegate expressed the hope that the code could contribute to the establishment of a stronger common vision inspired by German travelling craftsmen, and the expression of some frustration regarding the limiting expressive possibility of sticky notes: '...please lets discuss it's taking too long to write.'

The two sets of answers suggests that the establishment of a code is understood both as a defensive and as an outreach gesture. One first aimed at the mainstream media and then at 'the public' and then to the members of 'the community.' The first comment

suggests that Rappert's first question is interpreted, not as an opportunity to provide some meaning, but instead as an occasion to voice a dominant dichotomy in which doing and playing are stabilizing and productive activities while defending and defining are activities bringing confusion and stagnation. Similarly, the second comment, describing the code as a sort of minimal effort to demonstrate the legitimacy of DIYbio without the need for 'strict over regulation,' denote another dominant understanding of the relation between regulation and techno-science; where regulation is only perceived as a limiting and intrusive practice. Lastly, 'the public' and its reactions are both a reason to write the code, and a recipient of it. The representation of 'the public' that DIYbio members use similarly reiterates the still dominant representation of 'the public' among scientists (Besley and Nisbet, 2011). What is striking here, is that a group committed to a biology 'for the people,' nonetheless considers 'the public' as a potentially threatening entity.

While Brian Rappert attempted to provide a space for reflexivity, by asking participants to question the reasons for a code and its audience, his questions end up revealing what might seem surprisingly common understanding of science regulation and public perception among scientists. In concluding this first interpretation, I find myself stuck in my own critical position. I feel irritated by what seems a sophisticated exercise in public relations, rather than a reflexive opportunity to think about the values sustaining the socio-technical vision of a personal biology. It seems that ethics as a process fails at enabling the emergence of a political consciousness among young/and or disenfranchised scientists. Should I return to a critical posture based on grounded critique as science and technology scholars often have? In an early interview Makenzie Cowell, disappointed with the 'huge barrier of entry for average people' in universities, he concluded that 'there must be another opportunity.' Similarly, as an ex-biologist-not-yet-turned into a science and technology scholar, I also believe that there *must be another opportunity* for a group of mostly young and/or disenfranchised scientists to think beyond dominant representations of science, the public or ethics. But how?

Matrix Structure Production

Back in the room, the participants looked tired. It was the middle of the afternoon and while the purpose of the code and who was its audience might, at that point, have been

commonly shared; how to transcribe their numerous concerns into shared principles still seemed elusive. This time it was Paine, the graphic recorder, who intervened as a facilitator. He left his cartoon-like and colourful sketch of the discussion and, in front of everyone, drew a 'code matrix.' A three row and three columns matrix articulating the code's aims (aspiration, educational, enforceable); the code's recipients (Media and public, Community network, Members); the code's status (Alert Standards, Guidelines, Prescriptions); and the code's types (Principles, Code, Constitution). Guided by columns and rows participants reminded each other that they aimed at an aspirational code, composed of principles, whose purpose was to alert and establish standards that would address the media and the public mainly. The grid, with its supposetly combinatorial clarity, seemed to relieve the participants of their doubts and spoken or unspoken unease. Once more, Flower directed the delegates' renewed attention towards the whiteboards where the sticky notes displaying delegates' reposes to the survey question 'What are your top three statements you feel strongly about including in a DIYbio code?' were put back up. The participants were once more invited to gather and Flower facilitated the clustering. Once the clusters were determined the participants were invited to chose a cluster, form small groups, and work out a principle from the cluster of post-it notes[18]. To do that, the six groups were given a sticky flip-chart pad, on which to stick the cluster of sticky notes, and half an hour. Once the time had passed they were asked to come back from their corners and in five minutes to present their work to each other.

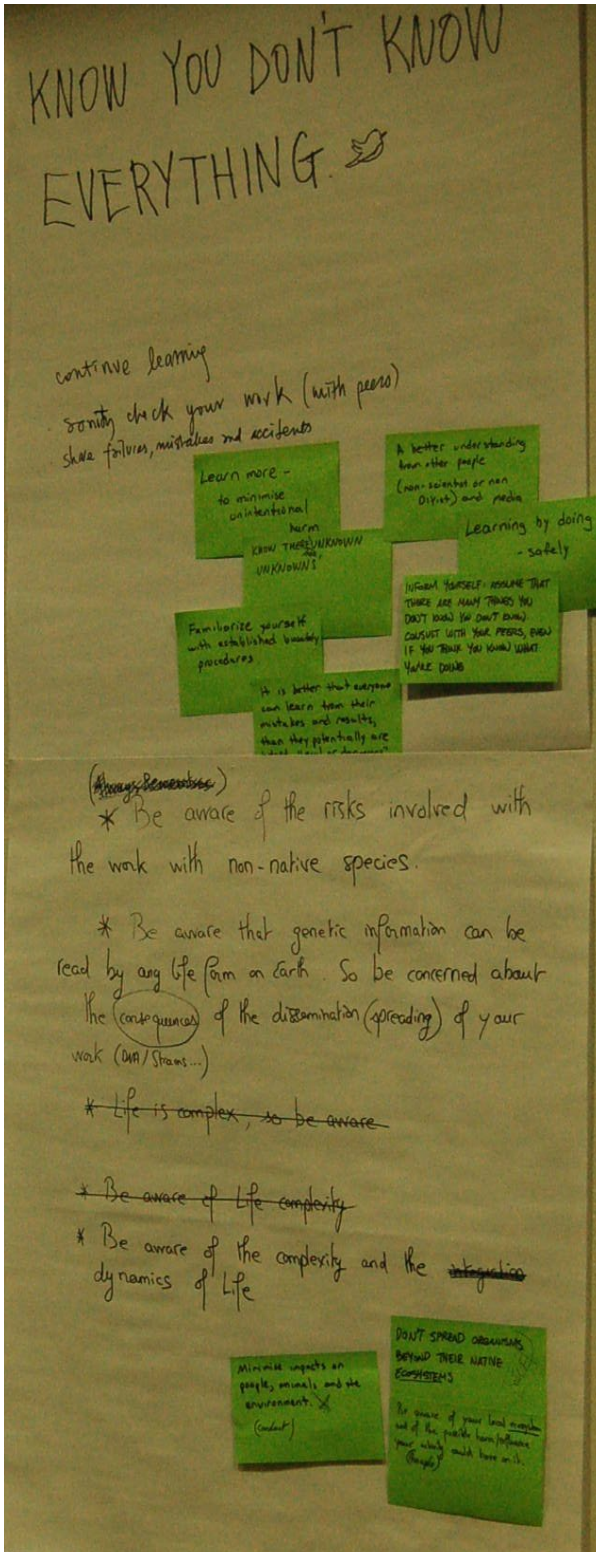
Due to the difficulty of describing how, out of each cluster, a principle was formulated, I decided to focus on the making of only one principle, then to resume the drafting of the first completed code.[19] As for the answers given by the participants to Rappert's questions, most of the principles conformed to the one of codes elaborated by professionals and amateur scientists alike (see last section). In this respect, I chose a principle that seemed different. This principle stated 'KNOW YOU DON'T KNOW EVERYTHING.' I first read this principle as an attempt to formalize the possibility that there are other forms of knowing, that others might know other things, and that

18 As for the other moment of clustering, I took a picture of the white board with the post-its, but I was a bit too far away, and the resolution of the picture is insufficient for me to read the text on the post-it notes.

19 This choice is also in part the result of the method I used to document this phase. As I decided to sit near different groups while they discussed their principles, I ended up with poli-thematic and fragmented notes that were later difficult to make sense of.

therefore our knowing is situated. But as I looked at the making of the principle, I came to a different conclusion.

Figure 5.4 The making of a principle.



Continue learning

[unreadable] check your work (with peers)

Share Failure, mistakes and accidents

[on the green sticky notes]

Learn more to minimize unintended harm

Know there are unknown unknowns

Familiarize yourself with the established biosafety procedures

It is better that everyone can learn from their mistakes and results then they potentially are [unreadable]

A better understanding than other people (non-DIYists) and Media

Learning by doing – safely

Inform yourself: assume that there are many things that you don't know, consult with your peers, even if you think you know what you are doing

- Be aware of the risks involved with the work with non-native species
- Be aware that genetic information can be read by any life form on earth. So be concerned about the consequences of dissemination (spreading) of your own work (DNA/strains....)
- Be aware of the complexity of life and the complexity and the dynamics of life-science

[on the green sticky notes] Minimize the impact on people, animals and the environment Don't spread organism beyond their native ecosystems Be aware of your local ecosystem and of the possible harm/influence that your activity could have on it.

In the image a snapshot of the writing work leading to the enunciation of a principle of conduct: KNOW YOU DON'T KNOW EVERYTHING. The green sticky notes display the clustered answers to the survey question 'What are your top three statements you feel strongly about including in a DIYbio code.' The remaining text was elaborated by the participants during the event. On the right the text transcribed from the picture.

In the image, the principle is followed by a stylised draw of a bird. The drawing reminded me that one of the advices given by the organizers was that the principles should be 'twittable.' In their study of the sense of audience as expressed by Twitter users, Alice Marwick and Danah Boyd (2010), propose the concept of a 'networked audience.' Defined as the combination of a 'writer's audience and the broadcast audience,' a networked audience is both potentially public and personal. In thinking of their definition I wonder if the organisers' advice implies such specific sense of audience, but also if the microblogging format, since most of the participants are Twitter users, epitomize the formulation of ethical principles as extremely succinct and compelling public phrase. If the iconic bird might symbolizes the desire for both a public and a personal form of communication to disseminate ethical principles, what about the desires conveyed by the principle itself? In the final version of the code, the principle is preceded by the noun 'Modesty.' It is with Haraway's critique of scientific modesty in mind that I review the making of the principle. Reconsidering Steven Shapin and Simon Shaffer's image of the 'modest witness' and of Sharon Traweek's expression 'culture of no culture,' Haraway proposed that the virtue of modesty is the one of 'self-invisibility' (1997: 23). In the post-it notes, modesty was expressed in terms of the importance of acknowledging and communicating failures, but also in respect of the necessity to learn continuously, and of doubting about one's own efforts, all of which were aimed at minimizing mistakes. Lastly, the phrase 'know there are unknown unknowns' summarized that the certitude of uncertainty is an experimental condition. The remaining phrases, elaborated by the delegates during the assigned time, exemplified on the whole some of the known unknowns, in the form of three specific warnings.

Claimed as an ethical principle, what type of modesty are DIYbio members enacting? Is it the same as that of the Victorian and modern scientist claiming it was not him speaking the truth, but the instruments and nature itself? Or a different one?

One elaborated in a century where technoscience takes place within an intensifying critique of progress, and where the modesty as self-invisibility might have instead become the modesty of acknowledging errors as intrinsic to techno-scientific practice? Should I interpret the phrase 'know there are unknown unknowns' as an acknowledgement that the production of uncertainty is at the very core of scientific practice (Beck, 1992), or instead, as Slavoj Zizek proposes, that the phrase only masks what we pretend not to know about (Zizek, 2004). In the latter case, is the problem with advocating a biotechnology available to everyone yet another empty vessel to salvation? Either way it seems to me modesty remains difficult to question from a position of the situated politics of one's own practice. If Victorian and modern modesty were characterised by self-invisibility; it seems that in the DIYbio code of ethics modesty is about visible regret in the face of the certain uncertainty of techno-scientific progress. With hopes and fears, regret might yet be another secularized trope still working for the maintenance of the new foundations. In this respect I wonder what type of political consciousness is possible under the secularized trope of regret as a redeeming hack, a quick fix to a second hand promise of techno-scientific progress? At the beginning of this interpretative exercise I explained that my choice of the ethical principle 'know there are unknown unknowns' was guided by the impression that it expressed the importance of considering how what we know is partial and situated. Instead, once more, closer interpretation brought me to the conclusion that after all such new modesty is at one with new limited reflexive possibilities. Before further consideration of the code's content, I would like to continue with the description of the concluding part of the process of the coding event.

Finalizing the code

Bobe, surrounded by the participants in the room, wrote each principle under the title 'CANDIDATE ASPIRATIONAL PRINCIPLES.' When a principle was not already phrased in a succinct manner, he condensed their phrases while listening to the ongoing discussions. The process was repeated, and further attention was given to the phrasing and participants' agreement with it. The 'NEAR FINAL CODE' was drafted on the board. Its seven principles were:

- Know you don't know everything
- We recognize the complexity and dynamics of living systems

& our responsibilities towards them

- We respect humans and all living systems
- Listen and respond to concerns
- ...we have fun...
  Enjoyment
- Strive to increase public understanding of the
  methods and implications of 21st Century Biology
- DIYbio emphasize the sharing of ideas, knowledge, data & results

As the day was almost over, the organisers moved the discussion on to how produce a final version. As they all knew that soon they were back online, Bobe volunteered to take charge of finalizing the language and to open a password protected blog. He would post his suggested changes so that delegates could comment on them, and reach a quick and final decision.[20] The participants agreed and as the end of the day was officially called, they seemed relieved and satisfied. They had achieved their aim, to write a code of ethics in one day. While they packed up they admired Paine's drawing.

Figure 5.5 Paine's graphic recoding.

Paine's colourful and cartoon like style overflowed with the productive creativity of the event, the transnational cosmopolitanism of the participants, their clustered

20 The aim of the organizers being to present a final draft of the European code at the occasion of the second 'coding event' to be held in the United States. Available at <http://diybioeuropecode.blogspot.co.uk/2011/06/preamble-modern-biotechnology.html?zx=f52b6c769126ac50>. Last accessed 12th January 2014.

concerns, its benevolent socio-technical vision, and its participatory process. It dominated the room, as an illustration that something – although as an observer I was not quite sure of what – has been achieved, and several participants took a picture of it with their smart phones. The graphic recording stood in stark contrast to my notes, where my rather sceptical portrayal of the event was recorded, folded and put back in my bag with little ceremony.

Before leaving the organisers invited the participants to take a collective picture, and shortly after the group slowly filtered out of the room. A small group moved off for a drink, while the rest went back to their hotels. I joined the group going for a drink but left soon after, tired both of the techno-utopianism still voiced in the discussions, and of my incapacity to think and feel beyond critique as a form of rejection.

The final code of conduct included ten principles. Their phrasing and order was modified. For instance 'Modesty' the principle that stood first at the end of the meeting had been moved down. Each principle was also preceded by a term intended to synthesize its aim. These last changes illustrate once more the curatorial work of the organisers. In its final form, the code was uploaded on diybio.org, the central website of the DIYbio network, where it is visible to 'all.'

Figure 5.6 Online code of ethics.

DIYBIO

Draft DIYbio Code of Ethics from European Congress

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 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.

The DIYbio Code of Ethics from European Congress as visible on the diybio.org website.

Uploaded on the central website, the code delimits the legitimate space of DIYbio, or at least for a portion of the DIYbio network and addresses the reader by providing a moral manifesto. This is a manifesto in the sense that the principles are written to be publicly displayed, rather than only circulated internally as part of a professional practice. Similarly other regional groups have also published the code on their web sites, in its original or a modified version. However such space is not only visible online. Offline, the code becomes a demonstration of how 'DIYbio: [is] Low Risk, [and] High Potential,' a phrase that is the title of an article published by Kuiken in The Scientist (Kuiken, 2013). In it, after criticizing the mainstream media's overblown

headlines, and describing how proactive DIYbio members have been in addressing biosafety and biosecurity, Kuiken concludes:

> There is no evidence to suggest that these efforts [DIYbio practices] pose undue risk to society, and the DIYbio community holds the potential to improve science education in the U.S., which was ranked 25th in math and 17th in science worldwide in a 2012 report from Harvard University's Program on Education Policy and Governance. Public policy should be written to enable the exploration and innovation of the DIYbio community—not to limit its reach based on overblown fears of the unknown.

By handing in the code, the metaphor of the personal computer, the figure of the biohacker and the socio-technical vision of a personal biology are returned to DIYbio's members. In this exchange, I argue, the politics of a personal biology has remained intact.

Ethics as a process or as a relation?

Framed by the expression 'the code is nothing, coding is everything' this second snapshot provided a description of what it might mean to practice ethics as a process. In what follows I will first resume the major elements of ethics as a process and discuss what I argue are its major constraints. This will enable me then to move to the concluding discussion on the relation between ethics as a process and ethical relating within a group of mostly young and/or disenfranchised scientists who constantly invoke 'the people,' as an otherness-in-relation to be empowered.

In the light of the description proposed, Rappert's practice of devising and revising has materialized in the particular form of a visionary workshop. Following a laborious period of design, the DIYbio European Congress took the form of a visionary and participatory workshop; a type of gathering that according to the organisers enabled structured productivity, structured creativity and structured collaboration. A structure of coming together that they understood as suitable for the writing of a code of ethics in one day. From nine am to six pm is in fact the period of time during which the gathered collective could afford to exist offline, as the event also marked the first off line meeting of the European members of the DIYbio network. Most of the participants had never seen each other offline, nor actually directly communicated online. In this sense, the meeting was as much about a group in-the-making than about a code of ethics in-the-making.

To enable such complex production, the setting was highly orchestrated. A room furnished with multiple communication technologies offered the actionable context: a large table, where the delegates could all sit together; a beamer to present definitions, the state of the community, aims and cautionary tales; a multitude of colourful sticky notes as tools to elaborate and share the surveyed or real-time opinions of the individual participants; several whiteboards on which to display and cluster participants' shared concerns and differences, and larger sticky flip-chart pads to enable small group work.

If the room offered an actionable context, the facilitators acted as an embodied steering device. By monitoring the relationship between the time and the steps of the event as designed, they kept the rhythm of the process going and ensured its fluency. As the main facilitator, Flower moved prolonged or out of topics discussions into the following activities, resolved situations that questioned the legitimacy of the event's design, invigorated the enthusiasm of the delegates when showing confusion, discouragement, disagreement or tiredness. He had to juggle the aims of the organisers whilst respecting the delegates' sense of individual and collective agency. The rhythm of production was also maintained, in a very literal sense, by assigning to participants defined amounts of time to answer questions, work principles out, and present their results in front of each other. In the role of second facilitator, Paine, the graphic recorder, drew a matrix which turned tiredness and doubts into clarity and illustrated the discussion.

To achieve an understanding of each others' perspectives, the establishment of common goals and the production of the code itself, ethics as a process was largely performed through fragmented conversations mediated by post-it notes. As such, during the event, sticky-notes were the central writing technology that enabled both the making of the group, as much as of the code. Written on sticky notes the answers that the individual participants gave to the online survey, or the questions asked during the event, became displayable and mobile. As a semantic object sticky-notes allowed the participants to move from the individual answers they gave online, to the collective display of concerns, as part of a group where members hardly knew each other. By being mobile and displayable the sticky-notes also allow for the assemblage of common concerns, and subsequently of common aims. Flowers achieved this assemblage through the process of clustering. As this process was performed in real

time by Flower, it became a supplementary participatory moment. Each member could see their concerns being shared by others, as well as appreciating the spectrum of concerns brought by other participants. Finally as the concerns were written, the discussion was defined, while remaining open to additional concerns of the participants.

In facilitating the process, the organisers also structured it in specific ways. For instance by choosing hopes and fears, I argued that they turned the production of secularized discourses of salvation and apocalypse characteristic of technoscience into relational tools aimed at establishing common understanding and organizational trajectories among members of a group in-the-making. This was a choice that excluded others emotions, especially those of a group of young and/or disenfranchised scientists as they attempt to define the practice of a personal biology. Similarly, I argued that in dealing with potentially disruptive moments, such as presenting Brian Rappert's talk as providing some answers, the organisers side stepped the possibility of participants thinking about their doubts concerning the production of a code of ethics as a mainstream institutional discourse. Similarly, moments of reflection, often framed in the form of precise questions, were timed. While constrained by time, the discursive possibility of the event was also constrained by the tool itself, as expressed by one participant who wrote '...please lets discuss its taking too long to write.' Comments, concerns, and opinions, were in fact limited to the one fitting the post-it size, and so was the development of a discourse about an ethics-in-the-making for a personal biology. Additionally by using sticky notes as a writing technology the content of the discussion was further constrained to the concerns of the participants. Ethics as a process relied on the continuous solicitation of participants' opinions, as such their concerns became the sole sources of an ethical discourse. This aspect was particularly evident in the discussion about the aim and the audience of the code, from which the effort is defined both as a defensive and outreach effort. Given the socio-demography of the delegates, the pool of concerns very quickly reflects rather common ethical discourses among young individuals trained in science: a commitment to the sharing of resources and modesty, the adoption of safe practices, the use of science for peaceful purposes, the respect of human and living systems and similarly a general sense of responsibility towards them. Their principles were supplemented with others reflecting a more recent reconfiguration of the moral economy of science such as

discourses of open access, here intended as a special commitment towards citizen science, the commitment to educate the public, to listen to the public's concerns and to remain accountable.

In Brian Rappert's work, ethics as a process is presented as the discursive practice of devising and revising with the purpose of establishing what constitutes an appropriate conduct. The phrase 'the code is nothing, coding is everything' is proposed as a critique of the tendency to evaluate codes of ethics in terms of their impact. Rappert's work, among others, suggests that the writing of codes of ethics has already become a highly participatory practice. These moments include for instance processes of broad consultation (Montoya & Richard, 1994; Snell & Herndon, 2004) but also procedures of communication, maintenance, and implementation (Kaptein & Wempe, 1998; Somers, 2001). In this respect, the aim of the chapter is not to argue that the DIYbio coding event represents a new or a more participatory way of making ethics per se. Instead my purpose was to highlight that, while praised as participatory and creative, the process seemed to remain impermeable to ethical issues that were not primarily those raised by the participants. A process that despite its orchestration, solicitations, and exercises of consensus building, somehow, I argue, still misses a deeper reflexive exercise. As an ex-biologist-not-yet-turned into a science and technology scholar, such missed encounters concern me. To address these concerns I turn to another perspective on ethics; one that does not describe and practice ethics as a process, but instead as a relation. Haraway describes this as an attitude marked by an ongoing alertness to 'otherness-in-relation' (Haraway 2003: 50): a notion according to which one can not know the other or the self, but that in the meeting of the two, one can experience both. In what I have described as the coding event, it seems to me that for the members of the DIYbio network, the otherness is the figure of the 'people' that they constantly invoke and ward off. In this abstract yet performative relationship the other is described as both the one to be empowered and the one whose irrational reactions are to be feared and avoided. The relation is in this case characterized by a mode of attention marked by a variation of the figurative saviour – the one who empowers, and a mistrust in 'the peoples' capacity to produce discerning opinions on science and technology matters. Instead, I suggested that in taking the time to express who 'the people' are, DIYbio members might become alert to an ingrained sense of responsibility to provide solutions in the form of technological innovations intimately

related to their position as scientists in the making.

Conclusion

I began this chapter by describing how the socio-technical vision of a personal biology was endangered by a hostile discourse, mostly disseminated by the mainstream media. A discourse that ironically made use of yet another interpretative diffraction of the same analogy used by DIYbio members: that of the personal computer. This analogy was quickly supplemented with the trope of bioterrorism and common shock phrases resurrected from the GM controversy. As the socio-technical vision of the DIYbio network was in danger, Jason Bobe, a DIYbio co-founder, in his role as a director of the community, asked, in front of a room filled with employees of American Governmental agencies, 'how do we build a positive culture around using technology and become good biocitizens?'

Framed by this question, and in particular the juxtaposition of 'good' and 'biocitizen,' this chapter described the preparation and the proceedings of the DIYbio European Congress, during which the invited delegates produced a code of ethics. By following these events, my aim was to figure out what becoming a 'good biocitizen' might mean. In the first snapshot I traced the laborious preparatory phase from which Bobe emerges as a person capable of establishing numerous and productive collaborations with influential think tanks and scholars. I argue that in taking care of this work, Bobe demonstrated that, as for the making of web content, the organization of public demonstrations, or the setting up of community and individual laboratories, policy making becomes just another 'making' that the DIYbio network needs in order to thrive. In this sense, being a good biocitizen means networking with influential institutions to secure the thriving of one's own socio-technical vision.

In the second snapshot, I traced the proceedings of the DIYbio European Congress. My aim was to characterize ethics as a process, then to elaborate on the distinction between ethics as a process, where the process is a creative and participatory visionary workshop, and relational ethics as a commitment to ongoing alertness to otherness-in-relation. I did this because it seemed to me that in the distinction between ethics as a process, and ethics as a relation, I could ground a second interpretation of what being a good biocitizen might mean. In doing this I have attempted to follow the emotions attached to the ethical process, including my own as

a person who has dropped out of science but drifted towards the critical promise of science and technology studies rather that of a personal biology. In particular, I argued that ethics as a process is a way of turning a conversation into a productive process; a process requiring an actionable context, the work of the facilitators and sticky-notes as writing technologies. A process that, despite having been designed to be participatory and creative, remains impermeable to ethical discourses and preoccupations that are not the ones provided by the participants themselves. Despite the stress that the organizers place on the importance of coding as a process of devising and revising, the code is also a product that is

put at work online and offline as a moral clearance for the socio-technical vision proposed by DIYbio members. Ethics as a process also remains impermeable to the condition of young individuals trained in science and in particular to the imperative of being useful and helpful via the specific act of providing 'technological solutions;' in the case of DIYbio members, by empowering 'the people.' In the process I argued that the politics of a personal biology has remained intact. It is in this sense that ethics as a process, I argue, is a central descriptive factor to the self-fashioning of a good biocitizen[21]. It seems to me that a good biocitizen is one who practices ethics as a process, as described in the previous snapshots.

Without forgetting that Jason Bobe defined himself as a 'white boarder' – meaning a person prone to the creation of neologisms – and following what I have discussed in the chapter, I would like to conclude by thinking of the notion of the 'good biocitizen' through the way in which it resounds with scholarly traditions that use similar terms. If, in the case of the composite neologism 'DIYbio', the semantic space thus opened was partially in need of definition, the semantic space of 'biocitizen' is packed with a dense and at times contradictory intellectual tradition. This tradition is that of biopower and its reconfigurations. In particular, I am interested in the notions of 'biological citizen,' developed by Adriana Petryna (2002) and of 'biological citizenship' from Nikolas Rose and Carlos Novas (2003).[22] The authors investigate how the current development of genomics, biotechnology and biomedicine participates in the reconfiguration of subjectivity, politics and ethics. In her work on the implosion

21 More recently the term has also been used in the form 'participatory biocitizen' to promote the use of crowdsourcing to gather participants to personal genomics and quantified self studies (Swan, 2013). The authors Melanie Swan is related to the regional DIYbio group in the Silicon Valley.

22 In their paper, Rose and Novas acknowledge the use of the term in relation to the work of Petryana (2002).

of citizenship and sickness in the uncertainty of post Chernobyl and post Soviet Union events, Petryna traces the emergence of a distinct type of civic self-fashioning as the capacity to negotiate social and economical inclusion based on medical, biological, and legal criteria (2002). In their work, Rose and Novas propose an overview of how beliefs about the biological existence of human beings encompass citizenship projects. Within their typology, an aspect that I find helpful to situate the notion of good biocitizen, is the productive tension between what Rose and Novas describe as the making up of biocitizen from above and from below. With the term 'above' they point at the role of political or economical authorities, and with 'below' they indicate the increasing participation of mostly collectively organized individuals in their self-fashioning as biocitizens. In respect of these propositions, the self-fashioning of good biocitizens seems very much part of a similar set of preoccupations, although one advocating a personal relationship to biology and biotechnology as a creative and enterprising responsibility, a type of making to be positively embraced rather than a condition to be dealt with. The citizen in the “good biocitizen” of Jason Bobe is, I argue, very similar to what Reardon has called the 'learned person' (2010), an in-the-know member of the digerati and empowered individual who has the socio-economical capacity to make and unmake decisions upon his or her own biology. If, as Jennifer Reardon argues, personal genomics has created a powerful zone of biosocial formation by 'yoking the locus of agency in liberal democracy – the 'person' – to the locus of agency in the life sciences – genomes' (Reardon, 2011: 95), Bobe's neologism of the 'good biocitizen' further expands, at least discursively, such loci. In this case the agency of creatively doing, rather than that of knowing or understanding one's genetic information, is at the core of the legitimizing project underpinning ethics as a process of the good biocitizen.

Conclusion

Methode is Erlebnis.

Leo Spitzer, 1948.

In presenting the conclusion of my work I would like to do two things. First, I would like to take a snapshot, but of myself. Secondly, I would like to revisit my major findings in the light of this last snapshot. In the methodology section, I presented the snapshot as a way of engaging with the transient discourses and practices that, I argued, mark the self-fashioning of the DIYbio network. A network that, across my snapshots, I have presented as mostly composed of young and/or disenfranchised scientists committed to the realization of a more accessible science. Following such commitment, I argued, DIYbio members are attempting to turn biology and biotechnology into yet another personal technology. A technology that can be blogged about, showcased during craft fairs, practised in the collective intimacy of homes or community laboratories, and be accompanied by a code of ethics for the good biocitizen.

In applying the tool of the snapshot to myself, my aim is to take an autobiographical look at the role that, as an ex-biologist-not-yet-turned into a science and technology scholar, I have played in this research. Then I will revisit the four major themes in this work. These are: the self-fashioning of a user-friendly biology, the making of a personal biology, laboratories on a shoe string as a techno-utopia-in-the-making, and the good biocitizen as a figure productively embracing a more 'democratic biotechnology. By doing so my wish is to reflect upon my relation to the participants of this research, as well as to re-consider my understanding of their work.

When thinking about what to call this autobiographical snapshot, the expression that kept coming to mind was 'the elephant in the biography.' In adapting a common figure of speech, I am not interested in the idea that there is something massive in the room, but that everyone – in this case me – avoids it. What I would like to capture with such an expression is that what is visible to me is very much in-the-making, that what has to be addressed seems to constantly change and go beyond the boundaries of what I am looking at. For the scholars in the field of Science and Technology Studies that I have come across the relation between their research subject and the position they speak from seems, when they take the time to make it explicit, an

issue that they straightforwardly contain in a brief section of their methodology. However, what seems very clear to them, seems to me to be as much a methodological as an existential issue. Leo Spitzer, citing Friedrich Gundolf, wrote, 'Methode is Erlebnis' (1948: 45). It is in this sense that I understand my own inquiry as a reflection of my consciousness at work. This autobiographical snapshot is therefore about the story that I have come to tell myself as an ex-biologist-not-yet-turned into a science and technology scholar. But it is also about how this story is significant for the interpretative work that I have produced throughout my thesis.

An elephant in the biography and thesis

This story begins with me, a drop-out from biology. I was trained as a biologist in a university where a group of scholars set up a compulsory course called 'Biology and Society.' Their work was influenced by the mixed legacy of the radical science movement and the emerging field of Science and Technology Studies (STS). Although their teaching addressed a number concerns I had, I nonetheless struggled to reconcile my growing political awareness in relation to the environment, the politics of ecology and conservation and more generally, our relation to 'nature' as members of post-industrial societies, with how biology was taught at the time.

Unable to figure out a way to articulate my yearning for politics and the career requirements of a young biologist, I convinced myself that moving to a Ph.D. in the field of Science and Technology Studies (STS) would be an acceptable compromise. To a certain extent I am what Martin calls 'a refugee from science' (Martin, 1993). Although I found the metaphor of the refugee overly dramatic in this context, I certainly was leaving something. However instead of finding a group of dissident biologists on the other shore, I found the well-institutionalized field of STS. A research 'community' with its own politics and distinctions between an activist and an academic approach (Martin, 1993; Woodhouse *et al*., 2002). As I write these words, I am still surprised at the lack of a collective and situated discourse among members of my generation who drop out from biology. My impression is that, we have drifted towards the promised land of STS and have become 'assimilated.' Maybe for some the field has enabled them to achieve what they were searching for when they left science. Maybe for others it made them think that they were not made to be scientists in the first place, whatever that means. Regardless of such suppositions, the experience of

being a biology drop-out in the field of STS remains, as far as my experience goes, mostly concealed, a sort of elephant in our biographies.

In 'staying with the trouble,' I came to understand the choice of my research subject as a by-product of such displacement and in particular of what I later came to call 'my yearning for an 'empirical politics.' In using the term empirical politics I am not aligning myself to the vogue for the largely neo-liberal discourses of 'evidence-based' policy, medicine, social intervention and suchlike (Greenhalgh and Russell, 2009). Instead, by empirical politics I take this to mean a methodological tool as the end product of critical reflexivity. What I am searching for is a path guided by works such as *Decolonising methodologies* (Linda Tuhiwai Smith, 2012) but 'applied' to the life sciences.[1] This yearning for an empirical politics was triggered when my academic path was crossed by scattered fragments of the 'radical sciences movement' and other related initiatives. These have attempted to 'reform' certain institutional and epistemic practices within techno-science, often in alliance with scientists (Rose and Rose 1972; Werskey, 2006; Delborne, 2008; Quet, 2013; Péssis, 2014).

The more I progressed in my research, the more it seemed I went back to my own yearning for an empirical politics. If, as Haraway argues, figuration as a rhetorical practice enables one to escape from critical analysis, which often 'seem only to repeat and sustain our entrapment in the stories of the established disorders' (Haraway 2004: 86) then I wondered how figuration could become a practice for an ex-biologist-not-yet-turned into a science and technology scholar. Similarly, 'it could be otherwise,' a figure of speech that I have often heard as a way to describe a certain political project within STS (Woolgar, 2014) seemed a practice stuck in critique, relying on the persuasive agency of language. In a sense, I wondered what 'a practice of turning tropes into [other] worlds' (Haraway 1994: 60) might look like.

A the very beginning of my research I was therefore under the impression that the members of the DIYbio network were attempting to develop such [other] practices. That in a sense they were turning tropes into other worlds. It was by following this impression that, back in 2009, I came to frame my research subject. Its very first title was: 'How DNA became hackable: biohackers, DIY (Do-it-Yourself) biologists, amateur genetic engineers, or biopunks as an *alternative* form of practising biology?'

1 In particular, Linda Tuhiwai Smith's talk on the reassessment of inequalities in contemporary research methodologies as well as her reference to contemporary research initiatives that articulate laboratory practices and native politics (2013).

As my understanding of the discourses and practices of DIYbio's members deepened, the weight of the question mark became more and more important, and the term 'alternative' one that I looked at with increasing suspicion. Unsurprisingly, first impressions lead me towards something rather different. This was something that I only came to formulate in the final stages of writing. This is, a commitment to understanding how young and/or disenfranchised life scientists attempt to elaborate a political consciousness and an empirical politics at the productive margins of research fields such as biotechnology and synthetic biology. These are fields that are invested by strong hopes, targeted by intense financial investments and prioritised by funding agencies in their institutional and strategic organization of scientific work.

In focusing on the DIYbio network as a case study I was looking for a space where young and/or disenfranchised scientists were attempting to elaborate in their own way an empirical critique of contemporary technoscience.

In the introduction I argued that when computers, and more recently free and open source software, are considered for the work they have been doing and continue to do in the lifesciences, they have been understood mostly as metaphors, models, or as machines that researchers within scientific institutions use as they make sense of life. In this sense the work done with computers has been mostly been understood as operating at an epistemological or empirical level. In using Fred Turner's work (2006a), I proposed that computers, and in particular personal and networked computers, should also be considered in their role as a techno-utopia. In this respect I argued that the DIYbio network is an important case study to look at the type of work that computers as a form of utopia are doing in the contemporary life sciences. By following and putting Turner's work in conversation with other authors, I proposed that personal and networked computers, as spokes-technology for a decentralized, egalitarian, and free society, are providing a re-configured techno-utopian space where young and/or disenfranchised scientists are making sense of life in their own way.

In reaching this understanding I concluded that if, on the one hand the socio-technical vision of DIYbio members could be located within the legacy of a of digital utopianism, on the other hand I came to place myself within the reconfigured legacy of radical science movements and institutionalized science and technology studies. The elephant in the biography had become the elephant in the thesis.

In what follows I would like to revisit the four structuring themes of my work in the

light of a more explicit position as an ex-biologist-not-yet-turned into a science and technology scholar.

The self-fashioning of a user-friendly biology

In the first empirical chapter, I wrote that my aim was to go back to the well-trodden ground of the origins of the DIYbio network. Whilst scholars placed the formation of the DIYbio network in the 'off scene' of the iGEM (Aguiton, 2009 and 2010); as an *un*disciplined offspring of professionals in the field of synthetic biology (Roosth, 2010); my interest was in the processes of identity self-fashioning. This was within a group mostly composed of current or drop-out graduate and post-graduate students, but also of disenfranchised researchers or professionals who saw in DIYbio network a possibility to revive their passion for science.

In the sociology of science the formation of professional scientific communities is often understood in terms of 'emergence;' that is through the development of laboratory instruments, different interest groups come to interact, resulting in the formation of identifiable communities (Mody, 2006). Others have theorized that the emergence of scientific communities is in terms of successive steps; the development of practices, the establishment of individual and institutional identities, and the formation of social identities (Gingras, 1991). More recent approaches have expanded these understandings by including concrete community-building efforts coordinated by national funding agencies aimed at the organization of scientific work (Molyneux-Hodgson and Meyer, 2009).

By using the term 'self-fashioning' and focusing on social media as a site of identity making, my purpose was to identify modes of formation not of scientific communities, but of communities mostly composed of science drop-outs, students and disenfranchised researchers or professionals. By using the the term 'self-fashioning,' I also wanted to highlight the capacity that DIYbio co-founders and members have to mobilize resources in the process of defining what a 'do-it-yourself biology' might be.

In the first snapshot, I portrayed DIYbio co-founders as young 'creatives' and mobile professionals circulating within and/or dropping out from powerful scientific institutions. In their moving from these institutions, I argued, they are busy figuring out a socio-technical vision according to which DNA sequencers would become cheap enough for everyone to have in their garage. Additionally theirs is a vision where the

barrier of entry to biotechnology would have to be lowered so that the practice of biotechnology could become accessible to everyone. In doing so their first product, I argued, was a neologism, the term 'DIYbio.' I proposed that this term functioned as a semiotic-material space to be inhabited. A space that was first realized in the form of an Internet domain.

In the second snapshot, I focused on social media and in particular on blogs as technology of realization. To do that I wrote a description with the list of the instructions used, followed by the actual content that DIYbio members put on the blog. Secondly I have analysed the making of the logo and the iconography of the poster entitled 'DIYbio revolution,' as one of the most used visual representations of the DIYbio network. Lastly, I have analysed the web content produced by DIYbio members on their blogs. In doing so I argued that, as for the neologism DIYbio, the mission statement published on the web was general enough to appeal to a wide variety of people who could then interpret and act upon it in their own way. By joining and figuring out what DIYbio meant for them, people would take initiatives which would then come to define the movement. In looking at the poster 'DIYbio revolution' I argued that its iconography symbolized the reconfiguration of political dissent as being a practice of participatory scientific transgression in the name of the people. I concluded the second snapshot by arguing that as for blogs curated by professionals-amateurs, blogs curated by DIYbio members offered a place where a virtual community, as an ideal community, could exist. A place where as young and/or disenfranchised professionals they could gather and produce web content shared via social media the subject of which was biology and biotechnology. In doing so I proposed that DIYbio members used their blogs to produce what I called a user-friendly biology; biology that because mediated by social media therefore was more accessible to everyone.

The making of a backyard biology

In the second chapter I pursued my understanding of how DIYbio members established their early practices. I was interested in the relation between the online establishment of a virtual community as an ideal community, and the places where such an ideal community could exist offline. To do so, I took a rather long detour. I located the making of a personal biology as part of much larger curatorial project of

the 'MAKE,' a project aimed at establishing a modern Do-it-Yourself culture.

In the first snapshots, I questioned the construction of 'the maker' as a figuration and the representation of technology it advocates. To do so, I traced the role of the founders of the maker movement as they constructed a figure to be inhabited. I argued this figure embodies the imploded legacies of the *Whole Earth Catalog*; the spectacle of American grassroots innovation as a source of endless economic rejuvenation; and a digital generation in search of carefully negotiated un-plugged realities. As part of the maker movement, the home and in particular its backyard and garage, but also Maker Faires, and other hospitable sites, become breeding reactors for small-scale and personal technologies. The maker embraces the entrepreneurial necessity of transforming his or her house into a business incubator.

In the second snapshot, I focused my attention on how biology and biotechnology were portrayed in the pages of Make magazine. In particular I argued that under the term 'backyard biology,' educational practices aimed at enabling amateur and garage science, but also more institutionalized forms of science education, became yet another tool in the hands of 'the maker.' Biology and biotechnology as 'backyard biology' have become yet another small-scale and personal technology. In the third and last snapshot I followed the re-appearance of the backyard biology projects. In particular I followed the molecular biology projects as they became part of DIYbio co-founders early presentations and practices. I argued that these projects served as literal illustrations that a Do-it-yourself biology was possible, and then as the very first practical demonstrations that a Do-it-yourself biology really was do-able. Lastly I followed DIYbio members as they progressively became regular and enthusiastic participants of Maker Fairs and the MAKE. I argued that in the MAKE, DIYbio members found an hospitable and stable forum. There they could meet offline, improve their skills as communicators, develop persuasive new public demonstrations, sell their prototypes and more generally, be surrounded by supporters of their socio-technical vision.

A laboratory on a shoe string as a techno-utopia in-the-making

If in the beginning finding hospitable online and offline forums was crucial for DIYbio members the next important phase, I argued, was to turn the socio-technical vision of a personal biology into a set of stable practices. The question of what it means and what

it takes to stabilize the practice of a personal biology, is at the centre of the fourth chapter. In the wider literature on DIYbio, interpretations of DIYbio practices have been expressed in the form of a dichotomy. Authors both praise them as unique yet also expose their limited scientific interest. However my interest lies in understanding how a socio-technical vision of a personal biology could be made into a different practice of biology and biotechnology. A practice through which a group of young and/or disenfranchised scientist would self-fashion their political consciousness. In particular, I proposed that the transience of these practices reveals the precarious financial or professional condition of its practitioners, and also the uncertainty of their epistemological and empirical propositions. In their attempt to consolidate their practices a majority of DIYbio members have organised regionally and formed community laboratories. These are run collectively; frequent activities include a variety of biology and biotechnology classes and workshops advertised through their social networks. The running costs of the laboratories are covered by subscription fees, class fees, scientific educational grants and fund-raising campaigns on the Internet. More recently funds have come from 'angel investors'. Most of the work is done on a volunteer basis.

Another way in which DIYbio members attempted to consolidate their position was in the creation of home laboratories. My choice of Cathal Garvey's home laboratory as a case study was due to an interest in his efforts to both turn the critique of mainstream technoscience into a profoundly different empirical practice but also how to make a living out of it. In the first snapshot I have described what Garvey calls an holistic biotechnology, one that not only connects him with the whole narrative of 'building species,' but also with that of 'fixing our mistakes.' Following Garvey's problematization of what he terms the 'poisoning' of research by commercial values, I traced how he defined his role as the 'enabler' of 'the people.' By putting biotechnology in people's hands, Garvey proposed that, in a sense, biotechnology can be 'fixed,' or 'healed' of the poison of commercial values. In this sense, he invokes 'the people' as an abstract entity to which he is committed to empower. I argued that to do this Garvey attempted to turn his political critique into an empirical practice. In the second snapshot I proposed that in order to put biotechnology into people's hands Garvey re-configures a number of common laboratory techniques and tools. He calls this 'creative substitutions.' Through creative substitutions he attempts to establish a

biotechnology that, he argues, is affordable, available and feasible. His assumption is that if he can do it than everyone can. This assumption marks Garvey's position as a young scientist who is attempting to develop a political critique of biotechnology, while at the same time taking himself as the example to be followed.

In the last snapshot I followed Garvey while he attempts to produce an open source plasmid as a tool aimed at being the backbone of an holistic biotechnology As his attempts to produce an open source plasmid fail, I ponder on the difficulties of striking a balance between the practice of an alternative biotechnology as a personal technology, and the possibility making a living out of it. I argued that in attempting, but failing, to turn his political critique into an empirical practice, Garvey actually demonstrates that his commitment to an holistic biotechnology is not, in his case, economically viable. Confronted with the imperative of being economically viable Garvey's empirical critique of the poisoning of research with commercial values actually looks like an empirical demonstration of the entanglement of economics interests and biotechnology.

Good biocitizens productively embrace a more democratic biotechnology

In the fourth and last empirical chapter, I pursued my understanding of the socio-technical vision of a personal biology by looking at how the members of the DIYbio network produced a code of ethics. The chapter centers on another identity-in-the-making, that of the 'good biocitizen.' The expression, was used by Jason Bobe, DIYbio co-founder, as he addressed a room full of employees of American governmental agencies. If in the previous chapter I implicitly looked at the values that DIYbio members posed in their socio-technical vision of a personal biology, in this chapter I looked at the explicit formulation of values as inscribed in a code of ethics in-the-making.

In following the preparatory phase of the DIYbio European Congress, and in particular the role of Bobe as a community director, my aim was to illustrate that policy-making became just another 'making' that the DIYbio network needed so that their socio-technical vision could thrive. By networking the socio-technical vision of a personal biology to the educational program of the Woodrow Wilson Centre and by designing the DIYbio European Congress as a creative and participatory workshop where ethics is presented as a process, Bobe succeeded in organizing an affordable

first gathering of the scattered members of the DIYbio network. In this sense I argued that being a good biocitizen meant networking with influential institutions in order to secure the growth of one own socio-technical vision.

I then pursued my description of the making of the good biocitizen by tracing the proceeding of the DIYbio European Congress. In looking at my field notes – including pictures; and also by progressively paying attention to the recorded reactions and emotions of the participants, as well as my own, I attempted to understand two things. Firstly, how the organizers implemented 'ethics as a process' in the form of a visionary and participatory workshop. Secondly I tried to understand the source of my surprise and discomfort at finding myself part of such an event. In attempting to describe 'ethics as a process I concluded that, in the form of a participatory and visionary workshop, the event was marked by the use of a variety of communication technologies and professional facilitators borrowed from think tanks. The implementation of 'ethics as a process' in the form of a visionary and participatory workshop appeared to be oriented towards a clearly defined objective: the writing of a code of ethics in a day, among a group whose members had not previously met offline. Additionally, ethics as a process was based on the continuous solicitation of participants' opinions. As the participants were,with few exceptions, young scientists, their opinions ended up reflecting a number of mainstream representations of science, technology and the public, held by scientists. Ethics as a process, implemented in the form of a visionary and participatory workshop results in the production of a code that is both defensive and an outreach gesture. A code whose defensive gesture is aimed at those who might not understand the potential of DIYbio and thus jeopardize its development, and the outreach gesture is meant at those who might be afraid because they are not knowledgeable about science. An defensive and an outreach gesture composed of ethical principles that are common to mainstream research. For a network whose members advocate a revolutionary democratization of science and technology it seemed that the revolution did not include their ethical reflections. I therefore argued that enacted as a process, their ethics failed to address the participant's emotions and reactions as an opportunity for collective reflections on the values of a personal biology. Another perspective on ethics as a process might be ethics as a relation. This is a notion that Haraway proposes is marked by an ongoing alertness to 'otherness-in-relation' (Haraway 2003: 50). A notion according to which one can not know the other

or the self but that in the meeting of the two, that one can experience both. In particular, in adapting Haraway's notion to the ethics-in-the making of a group of young and/or disenfranchised scientists, I argued that the abstract category of 'the people,' might actually be a place in which to experience ethics as a relation. I suggested that in taking the time to express who 'the people' are, DIYbio members might become alert to an ingrained sense of responsibility to provide solutions in the form of technological innovations. This imperative was apparent in the hopes and fears that participants expressed during the DIYbio European Congress, but, I argued, was not collectively questioned.

Instead, ethics as a relation, I proposed, might provide a space in which to collectively share the imperative of wanting to provide creative technological solutions for 'the people' and 'the world.' In present times when techno-scientific progress is highly contested by members of the public, this imperative might prevent DIYbio members from actually questioning what the problem is in the first place, and for whom.

The 'person' and 'biology' in personal biology

Throughout this thesis my aim was to illustrate that the formation of the DIYbio network can be understood as a reconfiguration of the socio-technical vision of a personal technology. A vision that first characterized the personal and networked computer and has since, for DIYBio members at least, come to include biology and biotechnology. For this reason, I have come to call such sets of discourses and practices a personal biology. Throughout my work I have described a personal biology as an epistemological and empirical practice of biology and biotechnology in-the-making. A practice established by a group of young and/or disenfranchised scientists in their uncertain attempt to come up with a technoscience with and of which they can live. A personal biology is documented, immortalized and made public using social media, and blogs in particular. Thus, it is a practice that embraces the myth of the Internet as a technology of democracy, participation and transparency. A personal biology is an adaptation of the reconfigured utopia of personal technologies as portrayed in the pages of Make magazine, and put in the hands of the makers. A utopia that results from the implosion of the legacy of the *Whole Earth Catalog*, the spectacle of grassroots American innovation, and a digital generation in search of carefully negotiated, unplugged socialities. A personal technology is practised in community

and home laboratories on a shoestring as a form of partial empirical critique of the status quo in public and private science. It calls upon the abstract category of 'the people' who, once they are empowered to do so, are supposed to produce a more holistic biology and thus truly beneficial biotechnology. Finally, a personal biology is also one that, to establish its legitimacy, is highly networked with influential institutions. Such a legitimacy is based on the capacity to use ethics as a process to produce codes and 'good biocitizens' while remaining impermeable to how, as a young and/or disenfranchised scientist, one might think about the relationship between technoscience and capitalism.

Following this description of a personal biology, the core argument in this thesis is that the socio-technical vision of a personal technology as first entangled with the personal computer, and more recently reconfigured in the open source software movement, has become inspirational for a group of young and/or disenfranchised scientists. These socio-technical visions of the computer, I argue, do not perform at a precise epistemic level such as other scholars have illustrated in the case of the computer as metaphors, machines or a models. Instead I argue that they perform at the level of the political theories of social change and associated practices that DIYBio members, as young and/or disenfranchised scientists, attempt to elaborate. By trying to turn biology into a personal technology DIYbio members are attempting, in somehow contradictory but non exclusive ways, to build a practice of biology and biotechnology with and of which they can live.

As part of the concept of a personal biology, the notion of the personal refers to both a type of material and discursive practices through which technology is envisioned as something small, portable, user-friendly and empowering: a tool for the transformation of individual and small group practices (Turner, 2006a). DIYbio can be considered as a space of personal exploration for emerging scientists for a generation of young and/or disenfranchised scientists. The person also stands for a specific type of personal liberties in reference to DIYbio members' description of scientific careers as elitist and/or poisoned by financial interests. But it also refers to the learned person as a highly educated individual whose agency is fully attuned with contemporary neoliberal knowledge societies. Therefore, from my perspective as an ex-biologist-not-yet-turned into a science and technology scholar, personal biology as a set of discourses and practices remains trapped in what seems like an unsolvable dichotomy,

where on the one side stand the emancipatory and participatory politics of the personal technologies, and on the other stand the unaddressed yet fiercely necessary politics of the collective and the social.

Techno-utopianism and political action as an unsolvable dichotomy? Then and today

In attempting to understand what I provisionally called a personal biology, I came to understand the socio-technical vision elaborated by DIYbio members as a reconfigured ideological descendent of digital utopianism. This is a reconfiguration that I attempted to trace across the four themes developed throughout the chapters presented above. However in carrying out this research, and in thinking of my own story as a biology drop-out I have also progressively placed myself within the legacy of the radical science movement; and its entangled and at times problematic relation with the institutionalized field of science and technology studies. This legacy is what I have come to call 'the elephant in the biography and thesis.' As I write these final remarks, I think that both myself and the majority of DIYbio members I interviewed for my research, being of the same generation, we have been 'hailed into existence'[2] by two reconfigured political legacies marking the late 60s, that both emerged from the counter-culture. Two legacies in part in which the role of technology in social change was understood in two distinct ways. The first saw in technology and science a site of struggle in which to expose the connection between science, technology and the maintenance of a capitalist oppressive regime (Moore, 2008; Quet, 2013; Péssis, 2014). As part of this legacy collective political action (including demonstrations, strikes, petitions, direct action, investigative and discursive critique, whistle-blowing, etc.) were believed to be instruments of social change. In relation to the second legacy, Turner writes,

> traditional political mechanisms for creating social change had come up bankrupt. Even if their peers organized political parties and marched against the Vietnam war, this group, whom I call the New Communalists, turned away from political action and toward technology and the transformation of consciousness as the primary source of social change.' Turner continues, 'If mainstream America had become a culture of conflict, with riots at home and war abroad,

2 The term refers to Haraway's use of Althusser's theory of ideology to point at the specific ways in which technoscience 'hails subjects into existence' (1997: 50). Here I try to turn the term towards myself in order to understand how certain political discourses and practices about technoscience hailed myself into existence.

> the commune world would be one of harmony. If the American state would deploy massive weapons systems in order to destroy faraway peoples, the New Communalists would deploy small-scale technologies – ranging from axes and hoes to amplifiers, strobe lights, slide projectors, and LSD – to bring people together and allow them to experience their common humanity. Finally, if the bureaucracy of industry and government demanded men and women to become psychologically fragmented specialists, the technology-induced experience of togetherness would allow them to becomes both self-sufficient and whole once again (2006:4).

Turner traces the formation of such a utopia, and follows its development throughout the eighties and early nineties when networked computers became the spokes-technology 'bring[ing] to life the countercultural dream of empowered individualism, collaborative community, and spiritual communion' (ibid.: 6). Turner also argues that digital utopianism and the networked entrepreneurship of influential figures surrounding Stewart Brand became an inspirational model for what many begun to call the 'New Economy.' Thus Turner's account does not tell

> the story of a countercultural movement whose ideals and practices were appropriated by the forces of capital, technology or the state. Rather it demonstrates that the New Communalist wing of the counterculture embraced those forces early on and that in subsequent years, Steward Brand and the Whole Earth network continued to provide the intellectual and practical context within which members of the two worlds could come together and legitimate one another's projects (2006a:7).

It is difficult for me not to be impressed by these words in present times traversed by fierce social struggles. Present times in which an increasing number of DIYbio initiatives receive support from national science education programs. But also present times in which an increasing number DIYbio activities receive the support of 'angel investors,' while DIYbio members progressively participate in start-up incubators and accelerator programs[3] with the hope of turning their vision of a personal biology and biotechnology into the next truly democratic scientific revolution.

My argument is not that, as has already been said, that technology has always generated utopian hopes, but instead that in the utopian element of personal technology, a group of young and/or disenfranchised scientists found a site in which to

3 See the currently ongoing ethnography of the DIYbio network from Sarah Choukah (forthcoming).

elaborate their political consciousness. In locating DIYbio members as part of the legacy of digital utopianism, and in particular in tracing its major reconfiguration throughout the four themes of my work, my interest was in understanding the empirical politics underlying the theory of a personal technology as a tool for social change. But also in figuring out how the socio-technical vision of a personal technology could become inspirational for the elaboration of an empirical politics within a network of young and/or disenfranchised scientists. In doing so I have also progressively located myself within the legacy of the radical science movement and its entangled history with the field of STS. A legacy that, as I briefly argued, developed a radically different set of theories but also practices concerning the role of technology in social change. For the purpose of this conclusion I have described these two legacies as distinct, if not opposite. However the more significant question is how in our present times, young and/or disenfranchised scientists elaborate empirical politics of technology for social change at the crossing of these and other legacies. After all, one might say, 'Methode is Erlebnis.'

Appendix One: Information Sheet

PhD Research information Sheet
NB: this sheet is given to research participants to keep.

How DNA became *hackable* : biohackers, DIY (Do-It-Yourself) biologists, amateur genetic engineers, or biopunks as an *alternative* form of practising biology ?

Who am I?

- Sara Tocchetti: Current sociology PhD student investigating biohacking and open source biology, supervised by Prof Sarah Franklin, BIOS Centre, LSE.
- 2008-2010 two years of working a teaching experience in the 'Biology and Society' program at the University of Lausanne, Switzerland.

What am I researching? Why is this research important?
In 2010-2011, I will conduct a field work to examine how different actor in the DIYbio/biohacking community design experiments, materials and protocols to practice molecular biology in different administrative and economic settings. My questions are aimed to explore how 'DIYbio/biohackerS' work individually and collectively and if DIYbio/biohackerS are practicing biology and biotechnology differently. What is the Big Bio, DIYbio/biohakerS are confrontationally talking about and referring to? How are they speaking about it and how are they organizing their alternative proposition? Finally to broadly contextualize this research, the existence of a continuum between DIYbio/biohacking and other experience of alternative scientific enquiry, as well as how DIYbio/biohacking as a case study relates to broader studies of science as culture, will also be questioned. Additionally I am also interested in exploring how DIYbio/biohacking reconfigure boundaries between scientific and popular culture due that a large descriptive work on DIYbio/biohackerS been done in the biopunk literature, films and video games.

What will this involve?

- I will focus on several main actors, of two of the liveliest DIYbio/biohackerS communities, San Francisco and Boston in the United States of America as well as otherimportant location, Davis, San Diego, Los Angeles and Seattle.
- I will primarily use ethnographic methodology, observing and participating amongst DIYbio/biohackerS. Note and selective recordings will serve as data
- Ethnography will supplements with semi-structured interviews, one-to-on and in groups when possible. Interviews will generally be recorded.
- I am also interested in shooting and editing a short documentary in collaboration with the community. This will involve filming.

How will the data be used?
Research data will be used in writing my PhD thesis; however, it may also be discussed at conferences, published in a book and academic journal. All the actors involved in this research will have access to the data.

Will your input be anonymous?

- Interviewees will complete a consent form; a choice is available to remain anonymous or to have one's name and/or occupation written in my work.
- Interviewees have the right to stop participation in an interview at any time or ask the researcher to have segments taken 'off-record.'
- I will be the holder and interpreter of the research data, however, upon a simple request, data can be accesses by participants.

Further questions? Please do not hesitate to contact me:
Sara Tocchetti: s.tocchetti@lse.ac.uk

Appendix Two: Consent Form

Consent form
*NB: this is the consent form I give to participants.

HUMAN SUBJECT CONSENT FORM 2010-2011
How DNA became *hackable* : DIY (Do-It-Yourself) biologists, biohackerS, amateur genetic engineers, or biopunks[68] as an *alternative* form of practising biology?

Sara Tocchetti
PhD Candidate, BIOS Centre, London School of economics and Political Science
http://www.lse.ac.uk/collections/BIOS/
s.tocchetti@lse.ac.uk

You have been asked in research conduces by Sara Tocchetti, PhD Candidate at the BIOS Centre, the London School of economics and Political Science. The purpose of this research is to explore how actors who define themselves as biohackeS practice biological inquiry. The research will be taking place in 2010-2011.

PARTICIPATION AND CONFIDENTIALITY
Your participation in the research will involve informal participant/observation interaction with Sara Tocchetti and being involved in interview (group or on-to-one). Sara will be taking notes and making selected recording. You may choose to remain anonymous, but Sara will ask permission to use your name and/or occupation in her work (below). Results of this research will be used for Sara Tocchetti's PhD Thesis at the London School of economics and Political Science. In addition, results may be blogged online, published in a book, academic journals and discussed at conferences. Sara Tocchetti will be the holder and interpreted of the research data; however upon request, data can be accessed by participants. You have the right to stop your participation in an interview at any time or ask the researcher not to record.

PLEASE TICK
[ ] My name, occupation and institutional affiliation can be written in Sara Tocchetti's work

[ ] My occupation and institutional affiliation can be written in Sara Tocchetti's work

however I would not like my name used

[ ] I would like to remain anonymous in any of Sara Tocchetti's work

[ ] I get to approve anything that refers to me in any way before completion

CONSENT
I understand the purpose of this research and my questions have been answered. I have indicated whether my name, occupation and institutional affiliation can be written or whether I prefer to remain anonymous. I understand that I have the right to stop an interview at any time during the interview, and to withdraw permission to use part of or all of the interviews material within reasonable time after conclusion of the interview.

I give my consent to participate in this research and to be interviewed.

…….....		…….....	
Participant's Signature	Date	Participant's Printed Name	Date
……		…….....	
Interviewer's Signature (witness)	Date	Interviewer's Printed Name	Date

Appendix Three: Fieldwork locations and events attended in temporal order.

Geographic Location	Field Work Location	Dates	Duration
London	London Hackspace	22/10/2010	Several months
		14/09/2011	
Paris	Tmp/lab – La Paillasse	08/02/2011	One day
London	DIYbio Summit – Code of Practice	07/05/2011	Two days
Ireland	Cork – Cathal Garvey Home laboratory	02/05/2011	One day
USA West Coast		10/05/2011	62 Days in total
San Fancisco	Maker Faire	21/05/2011	2 Days Days
		22/05/2011	
Moutain View	SNP Workshop	28/05/2011	1 Day
Los Angeles	DIYbio Weekly Meeting	29/05/2011	1 Day
San Francisco	DIYbio Summit – Code of Practice	14/06/2011	1 Day
USA East Coast		08/07/2011	28 Days in total
New York	Genspace	11/07/2011	13 Days in total
Boston	Sprout Kambutcha Night	22/07/2011	1 Evening
New York	Genspace workshop	30/07/2011	1 Day
Manchester	DIYbio UK Summit	29/10/2011	2 Days
Copenhagen	DIYbio and STS scholars meeting	17/10/2012	1 Evening
Paris	DIYbio Europe Kick off meeting	01/12/2012	2 Days
London	Lab Easy – Art Catalyst	13/03/2013	7 Workshops

Appendix Four: Table of primary actors

	Name	Education	Profession	Role	Interview date	Interview Length
5	Cathal Garvey	Bachelor's Degree in Genetics	Unemployed Biohacker-in-Chief Glowbiotics Ltd.	DIYbio member	02/05/2011	00:39
6	Joseph Jackson	AB in Government Msc, History and Philosophy of Science	Founder at Open Science Summit	Co-founder of Biocurious	23/05/2011 15/08/2012	01:39 01:00
7	Josh Perfetto	BS, Computer Science	Self -employed	Co-founder of OpenPCR, Co-founder of Biocurious	03/06/11	02:01
8	Tito Jankowski	in Bio engineering	Unemployed / self-employed	Co-founder of OpenPCR, Co-founder of Biocurious	21/05/2011 24/05/2011 05/06/2011	Informal convers.
9	Eri Gentry	BA, Economic	Genomera Community & Social Media Manager	Co-founder of Biocurious	20/062011	02:04
10	Kristina Hathaway	BS, Economics Certificate, HR Executive Program	Senior Consultant, People Team Rocket Fuel Inc.	Biocurious member	23/06/2011	00:50
11	Rikke Rasmussen	Msc in Biology	Unemployed	DIYbio member	23/06/2011	01:26
12	Melanie Swan	BA, French and Economics MBA, Finance and Accounting Master's Degree, Contemporary Philosophy, MA Candidate	Instructor Singularity University	Founder of DIY Genomics	23/06/2011	01:18
13	Jason Bobe	B.A., Molecular Biology Master of Science (MS), Management Information Systems	Director of Community for the Personal Genome Project	DIYbio co-founder	06/07/11 10/07/2012	00:59 01:30
16	Romie Littrell	BA, Molecular and Cell Biology PhD, Bioengineering	Curator / Exhibit Developer Health and Biotech at The Tech Museum of Innovation Fellow UCLA Art| Sci	Co-founder DIYbio SoCAL	08/07/2011	01:28
17	Cory Tobin	B.S., Biochemistry & Molecular Biology Ph.D., Plant Biology	California Institute of Technology Ph.D., Plant Biology	Member of DIYbio SoCAL	09/07/2011 23/07/2012	01:52 01:07

18	Tor Ruphos	-	-	Member of DIYbio SoCAL	05/10/2012	Written
20	Daniel Grushkin	Bachelor of Arts (BA), English Literature Master of Fine Arts, Creative Writing	Freelance Journalist	Co-founder of Genspace	30/07/2011 13/08/2012	01:22 01:20
21	Ellen Joergensen	Ph.D., Molecular Biology	Adjunct Assistant Professor, Pathology Dept. New York Medical College	Co-founder of Genspace	17/07/2011	01:14
22	Sung won Lim	Physics student New York University	Student	Co-founder of Genspace	15/07/2011	00:53
23	Oliver Medvedik	Ph.D., Molecular Biology	Unemployed	Co-founder of Genspace	19/07/2011 30/10/2011	01:53 01:29
24	Russell Durrett	MS, Biotechnology & Entrepreneurship	Research Technician Weill Cornell Medical College	Co-founder of Genspace	20/07/2011	00:57
25	Katherine Aull	BS, Biological Engineering	Unemployed	DIYbio member Boston	27/07/2011	01:32
26	Brian Degger	PhD in Biotechnology	Digital City Fellow Institute of Digital Innovation And self employed	DIYbio member Newcastle	30/10/2011	00:42
27	Asa Calow	-	Free lance web developer	Director of Manchester Digital Laboratory and DIYbio Manchester	10/07/2012	01:52
28	Hwa Young Jung	-	-	Co-founder of Mad Lab and and DIYbio Manchester	03/06/2012	02:31
29	Marc Dusseiller	Ph.D., Material Science, Nanotechnology, Biomedical Microdevices	Self employed and teacher	Co-founder of the Hackteria Network	29/04/2012	00:57
30	Rûdiger Trojok	Msc. in Biology	Student	Biohacker and member of DIYbio network (Germany)	08/10/2012	Written
31	Thomas Landrain	Msc. Interdisciplinary Approach to Life Sciences	PhD Student	Co-founder of La Paillasse DIYbio Paris	Unknown	With Sara Aguiton
32	Lisa Talheim	Master in Computer Science	Self employed	DIYbio member	05/10/2012	Written
33	Malthe Borch	Master of Science in Engineering, Biotechnology	Student	Founder of the BiologieGarage n	27/07/2012	1:56:07

34	Mackenzie Cowell	BS in Biology	Self employed	Co-founder DIYBio Founder of The Boston Open Source Science Lab And Cofactor Bio	22/07/2011	Informal convers.

Appendix Five: Table of secondary actors.

	Name	Education	Professional position	Interview date	Interview Length
14	Drew Endy	PhD, Biochemical Engineering BS; MS, Civil Engineering; Environmental Engineering	Associate Professor, Bioengineering Stanford University	05/07/2011	01:51
15	Eric Engelhard	Ph.D., Entomology B.S, Biology	Director of Information services at UC Davis	05/07/2011	00:46
19	Robert Carlson	Ph.D. in Physics	Consultant	03/07/2012 08/03/2013	01:46 01:22
35	Nils Gilman	Ph.D. in History	Historian and consultant	06/08/2012	00:50
36	Todd Kuiken	Ph.D. Environmental and Resource Policy	Coordinator of the collaboration between the Woodrow Wilson Centre and the DIYbio network	14/07/2012	02:00
37	Noah Flower	Msc In Philosophy	Consultant and analyst	22/07/2012	01:24
38	Edward You and Nathan Hilson	-	FBI Agents	01/07/2012	With Sara Aguiton
39	Kavita Berger	-	Senior Policy and Research Analyst at the Presidential Commission for the Study of Bioethical Issues	Unknown	With Sara Aguiton

	Name	Education	Professional position	Interview date	Interview Length
1	Howard Boland	BSc (Hons), Mathematics BSc (Hons), Software Systems for the Arts and Media MA, Digital Practices, Hyperfiction PhD, Art from Synthetic Biology	Director of Artistic Engagement at C-LAB	02/09/10	02:07
2	David Benque	BA, graphic & typographic design MA, Design Interactions	Research Associate at Royal College of Art	20/09/2009	00:37

3	Anna Dumitriu	BA (hons) Fine Art, Painting MA Fine Art	Artist in Residence on the Modernising Medical Microbiology Project at University of Oxford	14/09/2010	00:24
4	Kira O'Reilly	BA, Fine Art	Free Lance Artist	22/02/2011	01:01

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