Norms and Irony in the Biosciences: Ameliorating Critique in Synthetic Biology

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Abstract. *This essay responds to Paul Rabinow's contention that recent transformations in the practices and norms of the biosciences, exemplified in the emerging field of synthetic biology, demand corresponding changes to the forms of knowledge and practices used by humanities scholars and policymakers wishing to understand and engage with them. Rabinow's "Human Practices" approach embeds humanities scholars and social scientists with scientists in the course of ongoing research endeavors (so-called upstream engagement). This approach aspires to develop new ways of conceptualizing scientific and engineering practices, and to promote philosophical awareness among scientists and engineers—about what constitutes "the good life"—in ways that are coupled with scientific self-regulation. We wonder, drawing upon research traditions in the history & philosophy of science (HPS) and science & technology studies (STS), whether such an approach is likely to have much impact on the practices of synthetic biology. As our essay endeavors to explain, we doubt whether the environment(s) in which synthetic biology is being practiced will compel scientists to embark on these types of philosophical, social, and ethical reflections, or make them inclined to constructively engage with humanities scholars and social scientists. We also allude to the possible dangers of diluting external regulation and existing forms of accountability for scientists and engineers. Our essay concludes in a register skeptical of Rabinow's ironic response to the actual difficulties encountered in putting his philosophy into practice. This, we contend, indicates that more robust and reflective engagement with existing theoretical and empirical studies of science, engineering, and expertise would be at least as illuminating, if not, perhaps, as original.*

Keywords: *biopower, expertise, technology regulation, interdisciplinary collaboration, life sciences, law and science, human practices, collaboratory, engineering ethos*

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I. INTRODUCTION

Paul Rabinow is widely respected for the subtlety and sophistication of his scholarship, as a leading interpreter of the late Michel Foucault, for his anthropological studies of the biosciences, and for his attempts to articulate what might broadly be defined as the implications of biopower.[2] In this essay we respond to Rabinow's contention that recent transformations in the practices and norms of the biosciences demand corresponding changes to the forms of knowledge and practices used by humanities scholars and policymakers engaging with the biosciences. More specifically, our commentary assesses Rabinow's account of the emergence of the new field of *synthetic biology* and his participation in one of its flagship projects, namely SynBERC (the Synthetic Biology Engineering Research Center).[3]

There is, it is fair to say, some disagreement over the parameters of "synthetic biology" and residual disquiet over the appropriateness of the terminology. Generally, though, the *field* is understood to have "the deliberate design of biological systems and living organisms using engineering principles" at its core.[4] Some of the definitional issues, and some of the continuing controversy, are undoubtedly attributable to the relative novelty of the subject matters and approaches.[5] Chronologically, it is significant that the first international conference on synthetic biology was held as recently as 2004.[6] The SynBERC collaboration itself grew out of an application for funding to the National Science Foundation (NSF) shortly after this meeting when a group of scientists and engineers proposed to establish a program for research and development in synthetic biology in 2006. The grant proposal was successful and SynBERC was formed as an NSF Engineering Center. In addition to financial support from the NSF, SynBERC receives funding from a variety of public, private, and charitable sources. These include the state of California—where SynBERC forms part of the California Institute for Quantitative Biosciences—and a variety of venture capitalists and charitable trusts, including the Bill and Melinda Gates Foundation.[7] SynBERC's multi-institutional and multi-jurisdictional character is structurally entrenched. Participant researchers are based in the University of California campuses at Berkeley, San Francisco, and Santa Cruz, as well as at Harvard University, MIT, and Prairie View A&M University.

II. FLOURISHING AND THE DECONSTRUCTION OF PRACTICAL JUDGMENT

Rabinow has described the emergence of synthetic biology, along with his own participation in the SynBERC initiative, on a number of occasions. Understandably, here we focus primarily on the essay "Prosperity, Amelioration, Flourishing: From a Logic of Practical Judgment to Reconstruction" (reproduced earlier in this volume).[8]

One of the prominent features of Rabinow's approach to synthetic biology is a desire to capture and identify features of the emergent, and consequently not entirely settled, practices of synthetic biology. Part of Rabinow's ambitious approach is to simultaneously theorize and document his participation in SynBERC and the practice of synthetic biology. To a considerable degree these activities seem to involve the supplanting (i.e., discarding or ignoring) of traditional and implicitly inadequate vocabularies of bioethics, technology assessment, and science policy. We would include work by sociologists, anthropologists, and historians of science and technology among the alternative approaches that seem to be either trivialized or ignored. The purported novelty of synthetic biology and the implicit irrelevance of earlier scholarly endeavors encourage Rabinow to use qualifications and caveats, specialized neologisms, concepts borrowed from diverse fields of inquiry, allusions to classical scholarship, and lashings of irony. In consequence, his assessments are fraught with ambiguity and metaphoric tension. Whether such an approach is necessary, desirable, or even defensible, as a precursor to a potentially more enlightened understanding of contemporary bioscientific initiatives, or a reflection of the difficulties he appears to encounter articulating a clear intellectual and genuinely collaborative role for his vision of a Human Practices program of interventions into synthetic biology, is one of the issues we aim to explore.[9]

Rabinow opens his essay with an interpretation of the primary features of synthetic biology. Here, he places emphasis on the fact that synthetic biology is not merely another form of science but rather a form of "biological engineering [that] will invent and implement technologies that will make better living things."[10] Its practitioners, unlike the visionaries of genome sequencing projects, seem to value processes of standardization and modularization ahead of achieving abstract theoretical understandings. And synthetic biology is:

> developing in and renovating a tradition nicely labelled the "Engineering Ideal in American Culture." Synthetic biology aims at nothing less than the (eventual) regulation of living organisms in a precise and standardized fashion according to instrumental norms.[11]

Rabinow recognizes that moving beyond this orientation towards efficiency and instrumental capacity building "opens up a series of topics calling for inquiry and deliberation."[12] Topics associated with intellectual property and ethics, but especially those falling loosely beneath the rubric of risk—such as biosecurity, which Rabinow suggests are of concern to scientists and engineers—rank highly in his account.

Consistent with the call to move beyond contemporary forms of regulation, technology assessment, and STS (Science and Technology Studies) and ELSI (Ethical Legal and Social Impacts) theorizing about engineering and the sciences, Rabinow tends to dismiss more "traditional" ethical concerns, such as possible challenges posed by the new genetic sciences to the "qualitative distinctiveness of life." We are told, in an earlier essay by Rabinow, that:

> DNA itself is universal; if there are questions to be posed about the qualitative distinctiveness of living beings such questions must be posed at a different level. The specificity of species does not lie at the molecular level. The vision of the molecularization of life is, as they say, "so 90s."[13]

Rabinow's vision for the human sciences, contributing to understanding and addressing these "topics," is governed by an overriding commitment to the idea that the life sciences will embrace a particular style of engineering ideology that entails inevitable changes to the relationship between the human and life sciences.[14] (At a later point, we return to consider whether uncritical commitment to this metaphor may have subverted Rabinow's ability to develop a coherent Human Practices program capable of anticipating and ameliorating synthetic biology's social consequences.)

Moving more directly to SynBERC, Rabinow explains that the project is "designed around four core *Thrusts*."[15] Three of the Thrusts, namely Parts, Devices, and Chassis, are ostensibly technical: Parts is preoccupied with the "computational design and construction of cellular parts that can be assembled into 'devices'"; Devices involves "assembling cellular 'parts' into 'devices' that can be re-used in a combination of systems"; and Chassis engages in " building parts, devices, and systems that work inside living cells."[16] In combination they aim "to link evolved systems and designed systems, with emphasis on organizing and refining elements of biology through design rules."[17]

The fourth Thrust, in which Rabinow participates as a codirector, is described as Human Practices. Rabinow contends that this Thrust offers something quite different from the goals and strategies offered by more conventional attempts "to bring 'science and society' together into one frame so as to anticipate and ameliorate science's 'social consequences.'"[18] He continues:

> The task of Human Practices is to pose and repose the question of the ways in which synthetic biology is contributing or failing to contribute to the promised near future through its eventual input into medicine, security, energy, and the environment. The purpose of such a task is to assess this form-giving through critical examination.[19]

More specifically, Rabinow identifies the goals of Human Practices as bringing:

> the biosciences and the human sciences into a mutually collaborative and enriching relationship, a relationship designed to facilitate a *remediation* of the currently existing relations between *knowledge* and *care* in terms of mutual *flourishing*. If successful, such practices should facilitate our current work in synthetic biology—understood as a Human Practices undertaking—through improved pedagogy and the invention of collaborative means of response.[20]

Pedagogy is not interpreted in the ordinary senses of training or teaching but is instead implicated in Rabinow's concept of *flourishing*.

> Pedagogy involves reflective processes by which one becomes capable of flourishing. . . . it involves the development of a disposition to learn how one's practices and experiences form or deform one's existence and how the sciences, understood in the broadest terms, enrich or impoverish those dispositions.[21]

"Flourishing" is defined through reference to the classical term *eudaemonia*. Drawn from Aristotle's discussion of ethics, "eudaemonia" refers to the good life—happiness, fulfillment, and felicity. According to Rabinow, the SynBERC scientists are keen to prosper through career development, financial rewards, and the recognition associated with their research success. In practical terms, one of the main goals of Human Practices, following from Rabinow's recognition of the emergent qualities of synthetic biology and skepticism about traditional "science and society" approaches, is for human scientists through various processes of evaluation, facilitation, engagement, and collaboration, to encourage SynBERC's bioscientists to become highly reflective about their practices. It is out of this collaboration and reflection that the new practices constituting the discipline of synthetic biology will emerge. It is through consideration of how their practices enhance the good life that scientists and engineers (and human scientists) are enabled to flourish.

Although Rabinow acknowledges that the elite scientists and engineers engaged in Thrusts 1 through 3 (i.e. Parts, Devices, and Chassis) may not wish to collaborate, there is a sense in which resistance is unlikely to be sustainable:

> Adequate pedagogy of a bioscientist in the twenty-first century entails active engagement with those adjacent to biological work: ethicists, anthropologists, political scientists, administrators, foundation and government funders, students, and so on. Contemporary scientists, whether their initial dispositions incline them in this direction or not, actually have no other option but to be engaged with multiple other practitioners. The only question is how best to engage, not whether one will engage. Pedagogy teaches that flourishing is a lifelong formative process, one that is collaborative, making space for the active contribution of all participants.[22]

This is consistent with Rabinow's teleological belief that the biosciences are destined to embody a highly conventionalized engineering ethos.

We have not endeavored to reproduce all of the details of Rabinow's theoretical architecture or the complex relationships between the various concepts developed in an attempt to capture the subtleties of Human Practice praxis. Nevertheless, before proceeding it is useful to introduce the concept of *equipment*. Basically, "equipment" refers to the "truth claims, affects, and ethical orientations" that will be needed "to reconfigure and reconstruct the relations between and among the life sciences, the human sciences, and diverse citizenries both national and global."[23] Rabinow seems to appreciate that constructing equipment will be challenging.

III. PREPARING FOR THE GOVERNANCE OF SYNTHETIC BIOLOGY (BY HUMAN PRACTICES)

Looking beyond the broad programmatic rhetoric promoted by Rabinow, we can obtain an impression of the kinds of contributions that Human Practices might make to synthetic biology and, more specifically, compare them with more conventional approaches (including those associated with "science and society" and STS). Earlier we drew attention to the centrality of—and to some extent preoccupation with—risk and biosecurity issues associated with synthetic biology. Those engaged in the Human Practices Thrust have discussed security issues elsewhere, and these more detailed expositions help us to understand Rabinow's approach.

In an *Anthropology of the Contemporary Research Collaboratory* (ARC) concept note entitled "Response to *Synthetic Genomics: Options for Governance*," Rabinow and his colleagues, Gaymon Bennett and Anthony Stavrianakis, begin to explain how Human Practices might contribute to the governance of synthetic genomics.[24] In so doing they seek to distinguish their approach from more conventional orientations (and, at least implicitly, alternative approaches not considered) by critically reviewing a key report funded by the Sloan foundation: *Synthetic Genomics: Options for Governance* (hereinafter *Synthetic Genomics* or the Report).[25] According to Rabinow and his colleagues, *Synthetic Genomics* aimed "to formulate governance options that attempt to minimize safety and security risks from the use of synthetic genomics while allowing its development as a technology with great potential for social benefit."[26] The Report identified three broad sets of factors influencing security challenges from synthetic biology. They are technical innovation, the political environment, and uncertainty.

Rabinow, Bennett, and Stavrianakis contend that *Synthetic Genomics* addresses biosecurity issues within the frameworks of *safety* and *security*. Their critique, which follows, highlights the weaknesses of such framing choices. They explain how the *safety framework* in *Synthetic Genomics* inadequately addresses the problem of potential dangers by proposing the development of technical safeguards and procedures such as licensing and screening those who have access to DNA synthesis.

Rabinow, Bennett, and Stavrianakis suggest that:

> [t]hese measures are valuable as far as they go. However, given the kinds of problems identified in the [*Synthetic Genomics*] report, it should be clear that they are not sufficient. The report acknowledges that rogue scientists have ready access to the "know-how" if not the materials and technologies of DNA synthesis; what's more, these scientists may not form part of the community that would adhere to best practices. Neither challenges related to new political environments nor challenges introduced by uncertainty can be adequately addressed through the introduction of technical safeguards.[27]

The other approach to biosafety advanced in *Synthetic Genomics* is described as a *security framework*. The *Synthetic Genomics* report suggests that a security framework, in conjunction with the safety framework, provides a superior set of resources for dealing with biosafety. While Rabinow and his colleagues appear to recognize some overlap between these categorizations—for, notwithstanding technological preoccupation, safety frameworks involve licensing and regulation, which are implicitly linked to the broader political contexts in which the technologies operate—they argue for the supremacy of security frameworks because they more explicitly incorporate concerns relevant to the political environment. Examples might include the emergence of malicious and unpredictable actors, and the potential for new media to facilitate unprecedented access to scientific knowledge and technical know-how. Moreover, uncertainties may originate in foreign states and beyond the scope of traditional modes of regulation. The implications of such developments may be similarly promiscuous.

Nevertheless, Rabinow and his colleagues remain critical. For, although the security framework outlined in *Synthetic Genomics* may reveal uncertainties and risks, it endeavors to address them within the context of traditional governance frameworks and offers "no concrete proposals for developing frameworks" to confront them.[28] In contrast, Rabinow, Bennett, and Stavrianakis suggest that uncertainty requires a new approach, transcending the safety and security frameworks advanced in *Synthetic Genomics*. They propose, as an alternative, *preparedness*, and endeavor to explain how such an approach might be realized through Human Practices.

According to Rabinow, Bennett, and Stavrianakis:

> As a technical term, preparedness is a way of thinking about and responding to significant problems that are likely to occur (e.g. a bio-terrorist attack or the spread of a deadly virus), but whose probability cannot be feasibly calculated, and whose specific form cannot be determined in advance. In the face of uncertainty, a logic of preparedness highlights the need for vigilant observation, regular forward thinking, and ongoing adaptation. As with matters of security, the [*Synthetic Genomics*] report identifies challenges of preparedness, but offers no concrete proposals for dealing with such challenges.[29]

In linking "preparedness" to other aspects of Human Practices, such as collaboration, Rabinow's strategy for dealing with biosecurity issues would appear to involve reshaping scientific culture so it becomes more vigilant and more capable of managing uncertainty. Accepting that "preparedness" might subsume specific regulatory proposals, by offering a broad orientation in which specific regulations might be incorporated, it is far from obvious how this approach (and nomenclature) affords anything more concrete or viable than conventional approaches to uncertainty—such as those described in *Synthetic Genomics*—however familiar or flawed these might be.

Within the architecture of Human Practices, preparedness accords with Rabinow's commitment to the self-regulation (or internal regulation) of synthetic biology. Bioscientists, appropriately imbued via pedagogy and collaboration with human scientists, should have a sufficiently well-developed sense of flourishing to be trusted to undertake biological research with a sense of preparedness that would appropriately anticipate biosecurity issues and risks. Whether such a sense of flourishing would imbue bioscientists with the requisite skills to successfully undertake such a role is an obvious question. And such processes are likely to be far more demanding—to the extent that they are even possible or useful—than Rabinow implies.

In a recent Hastings Center report ethicist Michael Selgelid drew attention to some of the basic problems with proposals for scientific self-regulation in relation to bioterrorism:

> Scientists might be best able to recognize a discovery's scientific or technical implications for making particular biological weapons, but they have no special expertise to determine the identity, abilities, or intentions of potential bioterrorists. And scientists have no special expertise to assess what the *security*—as opposed to health—implications of attack with particular biological weapons would be.[30]

Amidst the criticisms of existing safety and security frameworks, Rabinow notes that part of their weaknesses stems from the inability to deal with (so-called "rogue") scientists not bound by scientific norms, and their failure to offer "concrete proposals." This last apprehension seems to be broadly based. The critique of *Synthetic Genomics* is, in consequence, exemplary. But this begs the question of how "preparedness" offers any substantial advance over existing approaches and known weaknesses. Interestingly, recourse to "preparedness" places the very norms and ethical sensibilities that are currently under considerable pressure from deregulation, privatization, commercialization (in the West), and the breakdown of governance structures through the fracturing of the states once composing the Soviet bloc in the East, under even greater strain.[31] Though sensitized to the need for policymakers to attend to developments and practices "upstream," Rabinow's approach implies a retreat from serious "downstream" engagement with science and scientific outputs and places considerable faith in surprisingly idealized bioscientific norms (more below). In this way the approach, thus far, seems naive in relation to both theorization and the possibility of constructing tangible spaces for effective upstream engagement.

The promotion of "preparedness" implies a strong capacity for collaboration between human scientists and bioscientists. Such collaborations, as Rabinow's own experience and frustration demonstrate (of this, more below), are fraught with difficulties. Moreover, in deference to his bioscientific collaborators, Rabinow and his Human Practices colleagues appear ill-prepared, and perhaps more poorly positioned, to prescribe, even in the most elementary terms, what types of regulation(s) and collaboration might assist with "preparedness" (and safety and security) and how they might facilitate "flourishing," along with the depth of collaboration required to generate the level of knowledge and competence needed to credibly regulate synthetic biological endeavors.

IV. UPSTREAM WITHOUT A PADDLE?

At this juncture we propose to consider how Rabinow's model of Human Practices might influence the development of synthetic biology and anticipate or ameliorate its social consequences. We aim to undertake this by: (A) unpacking the way Rabinow links "upstream engagement" with the *engineering ideal in American Culture*; (B) hypothesizing about what his visions for engagement might mean in practical settings involving interactions between law and the new biosciences; (C) interrogating "flourishing" and its apparently parochial implications; and finally, (D) noting that Rabinow's model of upstream engagement may not only be flawed in terms of its putative consequences but may not even be susceptible to instantiation.

A. Engineering Ideology in America

Proffering favorable parallels between the *engineering ideal* in American culture and the emergence of synthetic biology (along with a thinly veiled ironic allusion, to Fox Keller, that bioscientists will have a "feeling" for their organisms), from the outset Rabinow provides hints about his vision of the role of the analyst and its relationship to an engineering ethos.[32] On its face, the engineering ideology apparently motivating synthetic biology (and SynBERC) seems to leave limited scope for engagement with alternative conceptualizations of knowledge claims, or different interpretations of the direction of research, let alone provide the space or resources with which to contest the trajectories of technological innovation.

In a discussion paper endeavoring to explain the context for synthetic biology's embrace of the American engineering ideal, Rabinow drew upon the work of historian Philip Pauly:

> It was early in the century that a move away from the holism of the living organism and its milieu as a privileged and distinctive site of bio-science initiated a century long process that Philip Pauly has aptly called "biological modernism." Pauly identifies a key aspect of this process of the entry into the life sciences of what he calls the American engineering ideal of "just do it," and figure out later what it means or why it works.[33]

For Rabinow, the analyst appears to pay for his participation by becoming embedded—albeit upstream inasfar as he is actually participating in the early phases of technical development—in a seemingly linear process of technological innovation and application. Unlike other recent attempts to facilitate upstream engagement in science projects and research—such as through nanotech juries and consensus conferences, which aim to shape the direction of research/knowledge—the engineering ethos implies an engagement with the assessment and/or amelioration of the impacts of *existing* products and prototypes.[34]

An example that helps to illustrate the tendency for such an approach to drift into the realms of technological determinism and the promotion of "technological fixes" arises out of the claims made for one of SynBERC's most celebrated projects, the cheaper manufacture of a relatively scarce antimalaria medicine, artemisinin. Research and development funding for this project has been supplied by the Bill and Melinda Gates Foundation. While we do not quibble with the contention that the production of cheaper artemisinin via synthetic biology could save lives, particularly in developing countries, approaching the problem of malaria treatment/management from within an engineering framework may trivialize some of the broader social and economic factors involved in managing and treating the disease.

In an overview of the ethics of synthetic biology, produced for the IDEA League Summer School, at Delft University of Technology, some of the social problems with such a narrow vision of the processes involved in technical innovation are brought into view:

> Although a cheap drug against malaria would indeed save a lot of lives especially in poor Southern countries, it is the question whether the money invested in synthetic biology to create yeast strain to produce artemisinic acid . . . is the best and most efficient way of combating mortality of malaria. Farmers in East Asia and in some parts of Africa are growing wormwood or artemisia annua for drug production in developed countries and the farmers of wormwood would be out of business. There might be alternative ways of preventing people from dying from malaria, for example ways to prevent people from being bitten by malaria carrying mosquitoes.[35]

Moreover, the synthetic production of artemisinin is likely to operate in conformity with existing patterns of subservience and dependency. For it is unlikely, under existing trade regimes and intellectual property agreements, that developing countries will be able to manufacture or purchase synthetically produced artemisinin at affordable rates.[36]

Historically, and especially in the U.S. context, the "engineering ideal" signifies not only industrial technical experimentation, self-regulation, and rapid technical innovation, but simultaneously represents periodic failures, conflicts, lawsuits, and recriminations about paths both taken and avoided.[37] Rabinow's implicit rejoinder to the problem of the human scientist passively constrained in the frame of synthetic biology's engineering ideology is for their collaboration with bioscientists and engineers to facilitate processes of critical self- and social-reflection by these bioscientists about their work and its implications. Rabinow's analysis invests a high level of confidence in research scientists and engineers with a range of financial, professional, and personal interests in their research.[38] With something of a Saint Simonian view of benevolent technocracy, he suggests that the self-interests (especially prosperity) of bioscientists will have an easy correspondence with broader social ideals of prosperity (and flourishing).[39]

B. The "Collaboratory" in the Courtroom

Having examined some of the broader issues of Rabinow's vision we can move to consider some of the implications for synthetic biology in legal contexts. This focus, well suited to an essay for a law and literature audience, may help us to consider the value of Rabinow's proposal for retheorizing evidence law, intellectual property, and even the regulation of biomedical and bioscientific research. We pay particular attention to possible implications of Rabinow's models of intense collaboration, which would, if successfully adopted (through the collaboratory), encourage the dissolution of traditional boundaries of expertise.[40]

One point of departure is to consider the impact of new models of scientific practice and new models of collaboration on something as apparently mundane as admissibility jurisprudence. Significantly, scientific and technical evidence have, in recent decades, been credited with creating serious problems for courts in virtually all Western jurisdictions, but especially in Anglo-American adversarial legal cultures.[41] It is interesting to consider what the approach(es) promoted by Rabinow might offer to those involved in determining whether expert evidence should be admitted in legal proceedings, as well as how to understand bioscientific research and practice when applying intellectual property laws and/or adjudicating property rights (associated with new entities, processes and techniques).

While helping to draw attention to the complexity of bioscientific practice and collaboration, in pragmatic legal contexts the kinds of Human Practices approach being promoted would tend to substantially complicate practice with little conceptual or practical clarity and apparently few institutional benefits.[42] We accept that Rabinow's recognition of the multidisciplinary and even interdisciplinary dimensions of contemporary bioscience might capture some of the complexity of scientific practice and new types of institutionalization, but it is unlikely that U.S. courts would be particularly responsive to his extensive unfamiliar and idiosyncratic vocabulary to describe these new relationships.[43]

Furthermore, embedding social scientists or humanities scholars (such as Rabinow) with unclear (and even contested) status—regarding the nature and quality of their contribution to the production of synthetic biological knowledge/artifacts— would also be problematic in courts that may be confronted with the task of assessing or weighing the value of competing expert knowledge claims in the assessment of property rights, scientific outputs, or risks. U.S. courts have generally been reluctant to receive social scientists and humanists—even those with specialized research interests and experience in studying expertise, science, and technology—as expert witnesses where scientists, engineers, and technicians are available.[44] Human Practices personnel would probably have their participation in legal contexts, in disputes over ownership or regulation, limited to lay or eyewitness testimony. It would tend to be restricted to the provision of information about things like the dates when something was "discovered," observations about who "participated" in relevant work (based on ethnographic research or interactions with researchers), and possibly field notes to the extent that any of these might inform the reconstruction of events coproduced by the lawyers and scientists.[45]

Things don't improve dramatically when we turn to intellectual property rights and the regulation and promotion of science and technology. If anything, property rights tend to reflect power relations and, in scientific research at least, will tend to indicate the perceived utility of Human Practices (and social scientists and humanists) to those involved in bioscientific research. Here, notwithstanding the fact that scientists and engineers have for decades confronted a range of formalized ethical, funding, regulatory, and legal hurdles, property rights have primarily been invested in scientists, engineers, and their institutions. The other major group to obtain property interests are those actually supplying the capital. Unlike other participants, those in the Human Practices Thrust may have to flourish and prosper largely (or entirely) without direct access to property rights and profits. For the inclusion of additional *participants* threatens to dilute any dividends by extending them to those whose input may be perceived as anything from limited or trivial to unnecessary and imposed. Unavoidably, ideas about flourishing and prosperity are indexed to perceptions about the utility of contributions. Of interest, even those currently central to the socioeconomic organization of bioscientific research, such as intellectual property lawyers, and to a lesser extent ethicists (and ethics panels), have obtained few of the financial benefits beyond, respectively, substantial fees and new types of employment, engagement, and status.

As for regulation, the new conceptual apparatus and innovative multidisciplinary collaborations seem set to circumvent traditional forms of appraisal and/or preempt intrusive constraints (imposed by *outsiders*, particularly those "downstream"). Instructively, recent criticisms of biomedical research suggest that commercial sponsorship, and recourse to private research institutions (rather than universities and academic health centers) to conduct clinical trials, along with the suppression of *unfavorable* results, has afforded Pharma much greater control over the approval of drugs and therapeutics.[46] Notably, assessments of what counts as "unfavorable" tend to be as sensitive to marketing potential, profits, and corporate image as to efficacy and safety.

In recent decades there has been widespread condemnation of the deregulation of biomedical research—along with the fees and negotiation associated with the consensus regulation of pharmaceuticals and therapeutic goods.[47] One of the primary issues is concern that consensus regulation has made regulators familiar with and even financially dependent on those they are responsible for regulating. A considerable portion of the FDA budget, for example, is dependent on the fees paid by those whose products are being assessed. Regulators, in consequence, have been funneled into an asymmetrical, yet increasingly dependent, relationship. Research scientists are also exposed to conflicts of interests through their direct relations with private corporations and ownership of shares and/or property rights in the products they are developing.[48] Such conflicts of interest and the influence of private (i.e., for-profit) sponsors have created serious difficulties for medical practitioners and the technically competent staffs administering the leading biomedical journals.[49] Are there grounds for believing that embedded anthropologists (or other human scientists), whose prospects may be dependent upon the success of bioscientific research groups, will afford more effective forms of participation and regulation (regardless of whether they have an enhanced appreciation of the ways the research is being undertaken)? Will the participation of potentially interested nonscientists improve safety and security or will it facilitate further deregulation?

We can obtain some sense of the difficulties not only of regulation, but even of collaboration and participation, if we consider research into biofuels or the creation of new types of biological weapons. We can, for example, imagine some scientists and human scientists believing that attempts to develop biofuels may be inappropriate given the food implications for many of those living in developing countries. (This resonates with the earlier reference to artemisinin.) Principled objections to new types of biological weapons probably require even less explanation. Yet, if a human scientist was opposed to the use of biofuels or weapons research on principle (or for any reason—including conflicts of interest), would she be able to meaningfully participate in the collaboratory? If so, is her role one of "sabotage," or should she participate in an attempt to persuade? Based on Rabinow's experience in SynBERC, we wonder whether those with critical perspectives would ever be granted genuine opportunities to collaborate or flourish.

Here the possibility of participation and engagement might be illuminated by the experiences of jurors in death penalty cases. Typically, only those who believe in the death penalty and would, in principle, be willing to convict can serve on a jury in capital trials. It might not be considered insignificant that those who believe in the death penalty seem to be far more ready to convict. Jurors less committed to capital punishment, along with criminal defendants, often find it more difficult to flourish in these pro-death contexts. This leads us to ponder whether those embedded in synthetic biology collaborations—whether scientists or nonscientists—are typically positively disposed to the kinds of research and practice undertaken. And, if so, what effects will such dispositions exert on the potential for, and interest in, upstream regulation. To the extent that those involved in Human Practices are conflicted through property rights, rewards, ideological alignments, and even continuing employment, the hope of meaningful regulation, the interests of broader publics, and responses to critics would all seem to be at risk.

C. Flourishing in Perspective

Another problem, indexed to both the regulation and the success of synthetic biology and Human Practices, relates to "flourishing" and its reach. Most of the discussion of flourishing (and prosperity) in Rabinow's essay is directly linked to individual scientists and engineers with the hope that any localized success will somehow flow on to human scientists and trickle down to the broader U.S. society. There seems to be little concern about, or consideration of, the implications of these new types of organizations and interactions—euphemistically characterized as collaborations—for individuals and communities beyond the collaboratory.

In the way it manifests in Rabinow's writings, flourishing seems to be a particularly parochial concept. It is perhaps unremarkable to find that there is less discussion of the apparently important biosecurity dimensions, the implications of this work and what they might mean for those endeavoring to flourish in foreign domains or U.S. veterans' hospitals. We are left to wonder about the respective application of flourishing to those involved in producing biological weapons and those upon whom they are aimed (or might be aimed). We might also wonder about the appropriateness of a term such as "flourishing" to represent the success and prosperity of those involved in the generation of products, such as genetically modified foods, that have been opposed (on whatever grounds) by citizens in many liberal democracies. Though not considered, there may be tensions between localized flourishing within scientific research collectives and the vibrancy of participatory democracy.[50]

One of the curious features of Rabinow's work is the failure to theorize the relationship between parochial forms of prosperity, flourishing, and security and their implications for the prosperity, flourishing, and security of more remote national and international communities and individuals. On what basis does Rabinow, or his bioscientific collaborators, represent or accommodate the interests of others or their hopes, aspirations, and visions for the good life?

D. Collaboratory Life: Collaboration or Capture?

Notwithstanding their putative inevitability, the kinds of multidisciplinary collaborations advanced in Rabinow's writings seem to be fraught with practical difficulties. Unfortunately, these practical problems tend to be treated in an ironic or playful register. This response tends to supplant any systematic endeavor to consider their implications for the collaboratory or the development of pragmatic ways of addressing them.

From the outset, it would appear that even though synthetic biologists may acknowledge some of the social implications of their work, they maintain a conspicuous preference for forms of self-regulation.[51] Through reference to the origins of SynBERC, Rabinow and Bennett provide glimpses into strains that pre-date the Human Practices initiative. Even before Human Practices was conceived, there were tensions in the attempt to incorporate ethical, legal, and political considerations into SynBERC's broader scientific and technical agenda.

Rabinow was not in fact the first human scientist attached to the consortium. The NSF awarding the SynBERC grant was contingent upon the inclusion of an ethics component. To satisfy this condition, Stephen Maurer, a lawyer and adjunct professor in economics at Berkeley, entered the project. This first generation of human science engagement in SynBERC was short-lived. Maurer proposed mechanisms to monitor "experiments of concern" and procedures for the community of synthetic biologists to vote on a set of controls to govern their relationship with the emerging DNA synthesis industry. These proposals were ultimately published in a report funded by the Sloan Foundation but were not incorporated into SynBERC's operations.[52] According to Rabinow and Bennett, the ethics component of SynBERC broke down amid personality conflicts and disagreements over who would set the terms for governance and regulation.[53] In the wake of this breakdown Rabinow and Ken Oye, a professor of political science at MIT, were invited to take (over) responsibility for the ethics/human sciences component of SynBERC.[54]

Prior to his involvement with SynBERC, Rabinow was attentive to synthetic biology through his anthropological studies. He had, not insignificantly, been an invited speaker at the first two international synthetic biology conferences at MIT in 2004 and Berkeley in 2006.[55] Rabinow recounts how the invitation to join SynBERC offered an exciting opportunity to reinterpret the mandate from the NSF to incorporate ethical and social issues into its operations:

> [I]t would be an exciting challenge to try to think through and put into practice a "post ELSI" [Ethical Legal and Social Impacts] program. What this implied is that the mandated ethical, legal, and social implications program of the Human Genome Sequencing Initiative could not serve as a model for the future. Essentially the ELSI model (to simplify but not betray) had a mandate to work outside and downstream of the technical and scientific work. ELSI's directive was to deal with consequences, specifically "social consequences." There was a broad agreement that at SynBERC (as well as at the NSF funded nano-technology centers) the ethics work should be conducted alongside and collaboratively with the engineering programs.[56]

It would appear that Rabinow's more overt attempts at upstream engagement have also encountered difficulties. Rabinow notes that participation in the SynBERC collaboration has not always been smooth and that the power relations between the elite bioscientists, engineers, and human scientists place the last in a position of (continuing) subservience and vulnerability. We are told, for example, that "the PIs of Human Practices have been threatened in an e-mail with replacement, in what can be legitimately taken as a petty example of authoritarian power, unless we 'got along.'" Moving into a more ironic register, Rabinow suggests that "[u]pon reflection, and acknowledging our desire to prosper, we are now getting along."[57] By way of conclusion Rabinow indicates that he has developed an indignant resolve—"a cold vehemence"—to survive and gain "a more just recognition" of the "substantial efforts and contributions" delivered by the Human Practices strand of SynBERC.[58]

Perhaps a little obliquely, Rabinow acknowledges the considerable difficulties he has encountered communicating his Human Practices vision to the scientists involved in SynBERC's other Thrusts. Indeed, continued engagement seems to be contingent on compromising the breadth of his original vision. Even though Rabinow's vision for participation is more abstract than many other attempts at upstream engagement in science, is less prescriptive, and carries fewer obvious agendas (e.g., most commonly some notion of participatory democracy), he would appear to confront problems similar to other attempts at engagement with the sciences by social scientists and humanists.[59] Residing discourses are strongly shaped by rationalist or pragmatic orientations. Even though Rabinow's efforts acknowledge the pragmatic dimensions of undertaking bioscientific research, he appears to have difficulty articulating precisely what he can offer as a social scientist/humanist. Moreover, by conceding that so much of what is at stake depends on emergent and contingent properties and activities, he is left defending a space for involvement without a clear or prescriptive account of what the human scientist can actually do if such a space is secured. There is, in addition, little reflection on the costs or constraints of inclusion.

Aside from the frustrations caused by his subservient position in the power relations at SynBERC, we are tempted to suggest that Rabinow is suffering from an inability to characterize his professional identity.[60] While the scientists and engineers in the other Thrusts may well have hybrid identities as scientist/entrepreneur, be conversant with ethics and regulatory requirements and even with the broader political implications of their research, they nevertheless gain significant legitimacy and power from their primary identity and work qua scientists and engineers.[61] If SynBERC abandoned its Human Practices strand/pretensions it would still produce outcomes and outcomes that may not be conspicuously different. There are questions about whether Thrust 4 makes a difference to the social desirability of research and results, or the direction of research, or any substantial difference at all.

It is interesting to note that the difficulties experienced by Rabinow's largely experimental Human Practices approach are not altogether new or, perhaps, so surprising. In "Prosperity, Amelioration, Flourishing" he acknowledges drawing inspiration from the philosophy of John Dewey. Rabinow alludes to Dewey's contention that for political action to be effective it needs to be experimental and emergent, reaching beyond tradition and custom. Anticipating Rabinow's own difficulties, Dewey's "movement" was not favored by the scientists of his own time. Political philosopher Stephen Turner explains:

> John Dewey, in such works as *Human Nature and Conduct*, pronounced the experimental method to be the greatest of human achievements, and he promoted the idea of its application to human affairs, replacing "custom" and attainment of traditions, such as constitutional traditions, as a basis for political action. Yet Dewey distinguished the techniques of science from the spirit: he wanted the spirit, and its creativity, in politics, but not the techniques or the experts that employed them, or the experts themselves, who he dismissed as specialists and technicians whose work needed to be "humanized." This reasoning, and the movement it represented, was not attractive to scientists themselves.[62]

V. CONCLUSION

Though not readily accessible to many readers, several basic ideas can be distilled from Rabinow's rich assortment of distinctions, categories, and programmatic analysis. Rabinow appears to believe that synthetic biology should adopt a sophisticated form of self-regulation, predicated upon a reconfiguring of the norms, methods, and practices of bioscientists—though he uses the more elaborate concept of "equipment" to capture these processes. Reconfiguring is presented as a process of learning, somehow precipitated by collaboration between human scientists and bioscientists. In places Rabinow suggests that such collaboration and pedagogy are integral features of the engineering ethos of the new biosciences and, if not inevitable, then highly likely to eventuate. He never explains, however, why such collaborations are in fact inevitable and, in seeming contradiction, at times expresses frustration because attempts to facilitate or participate in these forms of collaboration are actually difficult. A convincing case for why synthetic biology needs such "equipment" is not provided, nor how new norms, methods, and practices can be reinforced and reproduced in the communities engaged in synthetic biological research and practice. It is not always obvious why pragmatic and entrepreneurial scientists and engineers should be inclined to engage, or engage earnestly, with those in Human Practices.

In this area, despite his obvious debts to Michel Foucault and the subtle and reflexive vocabulary Rabinow uses to describe matters of epistemology, (perhaps unwittingly) he appears to have much in common with the sociologist

Robert Merton. During the 1930s and 1940s Merton offered what has become a highly influential account of scientific norms and their social functions. This early work—influenced by Weber, though written largely in response to the rise of Fascism in Europe and concerns about its impact on scientific research—suggested that norms such as *universalism*, *communism*, *disinterestedness*, and *organized skepticism* were central to scientific activity and progress.[63]

Since they were originally proposed, Merton's norms have been subjected to considerable criticism. Those engaged in the empirical study of scientists and engineers—particularly historians and those involved in ethnographic studies of scientists, engineers, and their laboratories—have not generated evidence to support the contention that Mertonian-style norms guide (or have guided) the practices of scientists.[64] Rather, their currency seems to be more easily linked to various prefigured epistemologies of science (i.e., Mertonian norms should exist if science's objectivity is to be guaranteed) and they have been invoked as part of the public ideology of science. Interestingly, while idealized norms do not seem to be an essential feature of scientific practice, recent commercialization of many areas of biomedical science has introduced conspicuous tensions (e.g., private sponsorship and conflicts of interest) that make their maintenance even as part of the aspirational public culture of science ever more challenging.[65]

Rabinow's ideas about "prosperity" and "flourishing" distinguish his work from the simplistic models associated with Merton's early sociological offerings. Nevertheless, Rabinow's essay resonates with a Merton-type program. For his theoretical stance routinely implies or assumes the existence of ideal norms and social practices that are necessary (or intrinsic) to the successful practice of synthetic biology. Rabinow and those committed to the Mertonian framework gain greater warrant for their claims by insisting that the normative structure they have identified (for science) is intrinsic to science's survival rather than a code of practice or desirable state of affairs.

Understandably, Rabinow wishes to go beyond merely suggesting the desirability of upstream engagement in synthetic biology. However, he seems to warrant the involvement of Human Practices on the basis that it is somehow intrinsic or necessary to the evolution of new norms. In adopting such a posture Rabinow inherits extensive criticism of scientific norms. In particular, the contention that most normative systems have limited correspondence with the behavior of scientists; are not necessary for scientific success (for Rabinow "flourishing" and "prospering"); and raise questions about whether they should even be encouraged as desirable forms of behavior. Interestingly, notwithstanding extensive and persuasive critiques, Merton's norms of science have, as descriptions and aspirational ideals, achieved some resonance with the historical rhetoric and vocabulary of scientists. By contrast, it is less likely that Rabinow's complex vocabulary will be as accessible to practicing scientists, regardless of whether or not his nomenclature represents an improved approach to the practice and understanding of bioscientific research.[66]

We hope that Rabinow will continue his path of reflection in relation to the difficulties of successful collaboration and consider whether he has adequately characterized the features of the emerging engineering ethos of synthetic biology. While Rabinow may have successfully identified the entrepreneurial vigor and multidisciplinarity of synthetic biology, he may have failed to appreciate that the scientists and engineers may not require the type of contributions he aspires to provide. It may well be that rather than critique from the inside, the emerging engineering ethos associated with synthetic biology may require more intensified forms of (traditional models of) technology assessment and regulation. The capacity to evaluate the directions of new types of research at arm's length may well be a precondition to maximizing its social benefits so as to flourish rather than flounder. Instead of dealing with the failure of collaboration ironically, it may be that there is a need to retheorize engagement and/or consider the renewed importance of external forms of regulation.

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1. The authors would like to thank Elizabeth Silk for her research assistance.
2. Rabinow has received a number of prestigious awards for his work including the *Chevalier de l'Ordre des Lettres* from the French Government (1998) and the University of Chicago Alumni Association Professional Achievement Award (2000). On his contributions to biopower, see Paul Rabinow & Nikolas Rose, "Biopower Today," 1 *BioSocieties* 195 (2006); Paul Rabinow & Carlo Caduff, "Life—After Canguilhem," 23 *Theory, Culture & Society* 329 (2006); Peter Shorett, Paul Rabinow & Paul R. Billings, "Commentary: The Changing Norms of the Life Sciences," 21 *Nature Biotechnology* 123 (Feb. 2003).
3. The SynBERC Web site is at http://www.synberc.org/.
4. Andrew Balmer & Paul Martin, *Synthetic Biology: Social and Ethical Challenges* (Nottinghamshire: Institute for Science & Society, 2008), 7; Parliamentary Office of Science &Technology, Synthetic Biology Postnote 298 (Jan. 2008), www.parliament.uk/documents/upload/postpn298.pdf. For a comprehensive overview of the social aspects of the emerging field of synthetic biology see the SYNBIOSAFE [Safety and Ethical Aspects of Synthetic Biology] Web site at http://www.synbiosafe.eu/. The SYNBIOSAFE Web site is sponsored by the European Union and coordinated by Markus Schmidt of the Organization for International Dialogue and Conflict Management, Austria.

5. Jonathan Tucker & Raymond Zilinskas, "The Promise and Perils of Synthetic Biology," 12 *The New Atlantis* 25 (Spring 2006).
6. The First International Meeting on Synthetic Biology was held at MIT (June 10–12, 2004).
7. Alan Moses, "Intelligent Design: Playing with the Building Blocks of Biology," 8 *Berkeley Science Review* 34 (2005).
8. Several other essays of relevance are available online. See Paul Rabinow, "Test Case. Trust but No Confidence: Benign Indifference or Malign Neglect in Synthetic Biology," *Connexions*, Dec. 9, 2008, available at http://cnx.org/content/m18828/1.1/ (accessed Sept. 1, 2009); Gaymon Bennett & Paul Rabinow, "Invitation: Synthetic Biology and Human Practices: A Problem," *Connexions*, Dec. 9, 2008, available at http://cnx.org/content/m18812/1.2/ (accessed Sept. 1, 2009).
9. It is worth noting that narratives about origins, paradigmatic shifts, and future directions of emerging scientific disciplines can play important political roles in shaping both the assessment of their implications and their ongoing development. Some interesting parallels can be drawn with accounts about the "revolutionary" developments in nanotechnology. See, e.g., Cyrus Mody, *Why History Matters in Understanding the Social Issues of Nanotechnology and Other Converging Technologies* (Philadelphia: Chemical Heritage Foundation, 2008); Arie Rip, "Folk Theories of Nanotechnologists," 15 *Science as Culture* 349 (2006); Christopher Coenen, "Utopian Aspects of the Debate on Converging Technologies," in *Assessing Societal Implications of Converging Technological Development*, ed. Gerhard Banse, Armin Grunwald, Imre Hronszky & Gordon Nelson (Berlin: ITAS preprint, 2007), available at http://www.itas.fzk.de/deu/lit/epp/2007/coen07-pre01.pdf (accessed Sept. 21, 2009).
10. Paul Rabinow, "Prosperity, Amelioration, Flourishing: From a Logic of Practical Judgment to Reconstruction," 21 *Law & Literature* 302 (2009).
11. *Id*.
12. *Id*.
13. Paul Rabinow, "The Biological Modern," *ARC Concept Note* No. 6 (Feb. 2, 2006), 12 (emphasis in original) available at http://anthropos-lab.net/wp/publications/2007/08/conceptnote06.pdf (accessed Sept. 21, 2009).
14. Where we refer to human sciences it is our intention to include both social scientists and humanities scholars.
15. Rabinow, *supra* note 10, at 303 (emphasis added).
16. See SynBERC, *supra* note 3.
17. Rabinow, *supra* note 10, at 303.
18. Rabinow, *supra* note 10, at 303–04. Taking Dewey's advice literally, Rabinow makes little attempt to engage or even reference extensive literatures on the sociology and anthropology of science, technology, and engineering. Consider Sheila Jasanoff, Gerald Markle, James Petersen & Trevor Pinch, eds., *Handbook of Science and Technology Studies* (Thousand Oaks: Sage, 1995) and Edward Hackettt, Olga Amsterdamska, Michael Lynch & Judy Wajcman, eds., *The Handbook of Science and Technology Studie*s (Cambridge, MA: MIT Press, 2007).
19. Rabinow, *supra* note 10, at 304 (footnote omitted).
20. *Id*. at 305 (emphasis in original).
21. *Id*. There are now undergraduate courses in synthetic biology and competitions where students are challenged to build functional devices out of biological parts. See Erika Check, "Designs on Life," 438 *Nature* 417 (November 2005).
22. Rabinow, *supra* note 10, at 305.
23. *Id*. at 307.
24. Paul Rabinow, Gaymon Bennett & Anthony Stavrianakis, "Response to Synthetic Genomics: Options for Governance," *ARC Concept Note* No. 10, (Dec. 5, 2006), available at http://anthropos-lab.net/wp/publications/2007/08/conceptnote010.pdf (accessed Sept. 21, 2009).

25. Michelle Garfinkel, Drew Endy, Gerald Epstein & Robert Friedman, *Synthetic Genomics: Options for Governance* (Rockville MA: J. Craig Venter Institute, CSIS, 2007). This report was circulated in December 2006 and published the following October.
26. Rabinow, Bennett & Stavrianakis, *supra* note 24.
27. *Id*.
28. *Id*.
29. *Id*.
30. Michael Selgelid, "A Tale of Two Studies: Ethics, Bioterrorism, and the Censorship of Science," 37 *Hastings Center Report* 35, 41 (2007).
31. Stephen Collier, Andrew Lakoff & Paul Rabinow, "Biosecurity: Towards an Anthropology of the Contemporary," 20 *Anthropology Today* 3 (Oct. 2004).
32. Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (San Francisco, CA: Freeman, 1983).
33. Rabinow, *supra* note 13, at 4. The rhetorical links between molecular biology and its commercial potential have been present from the time of its initial appearance, particularly in the work of James Watson. See S. Michael Halloran, "The Birth of Molecular Biology: An Essay in the Rhetorical Criticism of Scientific Discourse," in *Landmark Essays on Rhetoric of Science*, ed. Randy Allen Harris (Hillsdale, NJ: Lawrence Erlbaum Associates, 1997).
34. This should not be taken to imply that attempts at upstream engagement are always straightforward or successful. For a brief discussion of initiatives associated with nanotechnology in the UK, see Nick Pidgeon & Tee Rogers-Hayden, "Opening Up Nanotechnology Dialogue with the Publics: Risk Communication or 'Upstream Engagement,'" 9 *Health, Risk & Society* 191 (2007). For a recent overview of these issues, see Alan Irwin, "STS Perspectives on Scientific Governance," in Hackett et al., *supra* note 18, at 583–607.
35. See the discussion in Synthetics: The Ethics of Synthetic Biology, IDEA League Summerschool, The Netherlands (Aug. 2007), Delft University of Technology, http://www.ethicsandtechnology.eu/images/uploads/Ethics_of_synthetic_biology.pdf (accessed Sept. 1, 2009), and Willem Heemskerk, Henk Schallig & Bart de Steenhuijsen Piters, *The World of Artemisia in* 44 *Questions* (Amsterdam: The Royal Tropical Institute of the Netherlands, 2006) available at http://www.kit.nl/smartsite.shtml?id=5564 (accessed Sept. 1, 2009).
36. Obviously, these arguments will vary depending on who owns the IP and how any product is manufactured and distributed. While tree cropping might not represent large numbers of jobs, the example indicates how particular technological frames might obscure implications or even close off alternatives.
37. Sheila Jasanoff, *Science at the Bar: Law Science and Technology in America* (Cambridge, MA: Harvard University Press, 1995).
38. By way of a thought experiment, we wonder whether having human scientists in U.S. banks would have influenced banking practices in ways that might have limited or reduced the recent (i.e., 2008–2009) series of collapses. Here, again, it is useful to reflect upon self-regulation by interested participants and what flourishing might mean, and for whom.
39. For a classic overview of various traditions and different interpretations of the meanings of technocracy, consider David Elliot & Ruth Elliot, *The Control of Technology* (London: Wykeham Publications, 1976), 51–101.
40. Hedgecoe and Martin suggest that notwithstanding claims that genomics has been transformational in terms of scientific knowledge, practices, and forms of public engagement, a more realistic assessment would address the unevenness of changes corresponding with different regulatory regimes and local political cultural and institutional factors. While Rabinow may be correct in identifying changes in patterns of laboratory practices and fields of expertise, his tendency to extrapolate and generalize patterns and the consequences of such changes might be difficult to sustain empirically. We will return to these

points later in this essay. See Adam Hedgecoe & Paul Martin, "Genomics, STS, and the Making of Sociotechnical Futures" in Hackett et al., *supra* note 18, at 817–39.

41. Jasanoff, *supra* note 30; David S. Caudill & L.H. LaRue, *No Magic Wand: A Non-Romantic View of Expert Testimony* (Washington, D.C.: Center for Public Justice, 2006).
42. To be fair, we understand that Rabinow has not turned his attention to this issue, but his reconceptualization does embody a range of implications and potentials that are worth contemplating. Here, we do not mean to suggest that the current state of affairs is ideal. As things stand, *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993) represents a confused model of science and is operationalized in ways that are not merely inconsistent but often lack principle. See Gary Edmond & David Mercer, "*Daubert* and the Exclusionary Ethos: The Convergence of Corporate and Judicial Attitudes towards the Admissibility of Expert Evidence in Tort Litigation," 26 *Law & Policy* 231 (2004).
43. See Gary Edmond & David Mercer, "Conjectures and Exhumations: Citations of History, Philosophy and Sociology of Science in US Federal Courts," 14 *Law & Literature* 309 (2002).
44. It would be our contention that metascientists in other traditions might offer more serviceable models, ironically, better suited to the exigencies of practice. Though, as the discussion by Lynch and Cole suggests, such interactions can be complex and protracted. See Michael Lynch & Simon Cole, "Science and Technology Studies on Trial: Dilemmas of Expertise," 35 *Social Studies of Science* 269 (2005). See also Harry Collins & Robert Evans, *Rethinking Expertise* (Chicago: University of Chicago Press, 2007).
45. Kara Swanson, "Biotech in Court: A Legal Lesson on the Unity of Science," 37 *Social Studies of Science* 357 (2007); Alberto Cambrosio, Peter Keating & Michael MacKenzie, "Scientific Practice in the Courtroom: The Construction of Sociotechnical Identities in a Biotechnology Patent Dispute," 37 *Social Problems* 275 (1990); Sheila Jasanoff, ed., *States of Knowledge: The Co-Production of Science and the Social Order* (London: Routledge, 2004).
46. See Gary Edmond, "Judging the Scientific and Medical Literature: Some Legal Implications of Changes to Biomedical Research and Publication," 28 *Oxford Journal of Legal Studies* 523 (2008).
47. Sheldon Krimsky, *Science in the Private Interest* (Lanham: Rowman & Littlefield, 2003); Wendy Wagner & Rena Steinzor, eds., *Rescuing Science from Politics: Regulation and the Distortion of Scientific Research* (Cambridge: Cambridge University Press, 2006).
48. Phil Fontanarosa, Annette Flanagin & Catherine DeAngelis, "Reporting Conflicts of Interest, Financial Aspects of Research, and Role of Sponsors in Funded Studies," 294 *JAMA* 110 (2005); Annette Flanagin, Phil Fontanarosa & Catherine DeAngelis, "Update on JAMA's Conflict of Interest Policy," 296 *JAMA* 220 (2006); Sheldon Krimsky, "Small Gifts, Conflicts of Interest, and the Zero-Tolerance Threshold in Medicine," 3 *American Journal of Bioethics* 50 (2003). See *infra* note 65.
49. The Cochrane Collaboration and the efforts by the International Committee of Medical Journal Editors are examples of attempts to overcome some of these problems. See International Committee of Medical Journal, eds., *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication* (2005), http://www.ICMJE.org.
50. Stephen Turner, "What Is the Problem with Experts?," 31 *Social Studies of Science* 123 (2001); Alan Irwin & Mike Michael, *Science, Social Theory and Public Knowledge* (Maidenhead: Open University Press, 2003).
51. Marcia Stone, "Life Redesigned to Suit the Engineering Crowd," 1 *Microbe* 566 (2006); Hans Bügl et al., "DNA Synthesis and Biological Security," 25 *Nature Biotechnology* 627 (2007); Laurie Zoloth, "Ethical Issues in Synthetic Biology: Security and Regulation in Experiments of Concern," A White Paper on the Ethics of Self-Governance in New Scientific Community (Chicago: Town Hall Meeting Series, Center for Bioethics, Science and Society, Northwestern University, 2006), available at http://www.synbioproject.org/topics/synbio101/bibliography/governance/ (accessed Oct. 10, 2009).
52. Garfinkel et al., *supra* note 25.

53. Bennett & Rabinow, "Invitation: Synthetic Biology and Human Practices," *supra* note 8.
54. At the time of writing (December 2008–February 2009) we are reliant upon accounts by Rabinow and Bennett. Maurer, and others who were involved, may or may not publish their versions of the matter in due course.
55. Bennett & Rabinow, "Invitation: Synthetic Biology and Human Practices," *supra* note 8, at 2–3 (Synthetic Biology 1.0: The First International Meeting on Synthetic Biology, MIT (June 10–12, 2004); Synthetic Biology 2.0: The Second International Meeting on Synthetic Biology, UC Berkeley (May 20–22, 2006)).
56. *Id*. at 5.
57. Rabinow, *supra* note 10, at 318. See also the works cited in note 7.
58. Rabinow, *supra* note 10, at 318. Perhaps revealingly, this episode reminded us of some of the interactions between the poor and those with power and affluence in Scott's studies of peasant resistance. See James Scott, *Weapons of the Weak: Everyday Forms of Peasant Resistance* (New Haven, CT: Yale University Press, 1985) and James Scott, *Domination and Arts of Resistance: Hidden Transcripts* (New Haven, CT: Yale University Press, 1990).
59. Consider, for example, the problems encountered by analysts in the debate between Collins, and Richards, Martin and Scott: Pam Scott, Evelleen Richards & Brian Martin, "Captives of Controversy: The Myth of the Neutral Social Researcher in Contemporary Scientific Controversies," 15 *Science, Technology, & Human Values* 474 (1990); Harry Collins, "Captives and Victims: Comment on Scott, Richards and Martin," 16 *Science, Technology & Human Values* 249 (1991); Brian Martin, Evelleen Richards & Pam Scott, "Who's a Captive? Who's a Victim? Response to Collins' Method Talk," 16 *Science, Technology, & Human Values* 249 (1991).
60. For the classic STS formulation of the processes of scientists establishing and demarcating their professional identities, see Thomas Gieryn, "Boundary Work and the Demarcation of Science from Non-science: Strains and Interests in Professional Ideologies of Scientists," 48 *American Sociological Review* 781 (1983); David Mercer, "Seen but Not Heard? Assessing the Impact of STS in Legal and Regulatory Settings Involving Controversial Science," in *Yearbook* 2005 *of the Institute for Advanced Studies on Science Technology and Society*, ed. Arno Bamme, Gunter Getzinger & Bernhard Wieser (Wien: Profil Munchen, 2005); Simon Cole, "A Cautionary Tale about Cautionary Tales about Intervention," 16 *Organization* 121 (2009).
61. David Mercer, "Hyper Experts and the Vertical Integration of Expertise in EMF/RF Litigation," in *Expertise in Regulation and Law*, ed. Gary Edmond (Aldershot: Ashgate Press, 2004), 85–97.
62. Stephen Turner, "The Social Study of Science before Kuhn," in Hackett et al, *supra* note 18, at 41–42.
63. Robert Merton, *The Sociology of Science: Theoretical and Empirical Investigations* (Chicago: University of Chicago Press, 1973), 266–78. "Communalism" and "communality" are often substituted for "communism."
64. Michael Mulkay, "Norms and Ideology in Science," 4 *Social Sciences Information* 637 (1979); Ian Mitroff, *The Subjective Side of Science* (Amsterdam: Elsevier, 1974).
65. Consider Kenneth Rothman, "Conflict of Interest: The New McCarthyism in Science," 269 *JAMA* 2782 (1993); Mario Biagioli, "Aporias of Scientific Authorship: Credit and Responsibility in Contemporary Biomedicine," in *The Science Studies Reader*, ed. M. Biagioli (New York: Routledge, 1999), 26; and Philip Mirowski & Mirjam Sent, eds., *Science Bought and Sold: Essays in the Economics of Science* (Chicago: University of Chicago Press, 2002).
66. Mulkay, *supra* note 64.