Human Practices and the Challenges of Upstream Engagement in Synthetic Biology?

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Abstract

Most promoters of synthetic biology highlight the fact that the emerging field not only offers the possibility of generating new synthetic organisms, but that it will also involve the development of new ways of doing biology through the adoption of engineering principles. Many synthetic biologists have been pro-active in generating discussions about what forms of regulation are appropriate to these new forms of knowledge and knowledge creation. The apparent novelty of synthetic biology has also stimulated a number of social scientists to suggest that new ways of doing biology also offer possibilities for new forms of collaboration and upstream engagement between scientists and social scientists. Possibly the most prominent recent attempt to put these ideas into practice can be found in the work of philosopher anthropologist Paul Rabinow in the SynBERC project in California. In the following discussion I will comment on Rabinow's project and other proposals for collaboration, and highlight some of the challenges faced by social scientists in developing meaningful collaborations with synthetic biologists.

Synthetic biology / background

Synthetic Biology (synbio) constitutes one of the newest areas of activity in the biosciences, its first international conference only being held in 2004. The emerging field has been described in a number of ways. A common starting point has been: '*the deliberate design of biological systems and living organisms using engineering principles*'. In fleshing out this definition there is normally an emphasis on the possibilities of using standardized biological parts and shared information registries to assist in building designer organisms from the absolute minimal possible genetic/chemical components (Endy 2005). These enterprises are envisaged to be even

more directly goal orientated than existing biotechnology. It is assumed that 'more than enough' is known about the basic science required, so what is needed is a revolution in the knowledge and approaches to developing applications. Inspiration, in terms of developing the appropriate professional structures and regulatory frameworks for the emerging field, is drawn from recent experiences of knowledge convergence and interdisciplinary collaboration in nanotechnology and the deregulated and entrepreneurial orientation of the IT industry (Moses 2005).

In reality the field is obviously more diverse than these ideals and as the term becomes more fashionable it is probable that more areas of biotech research will adopt the label, although it is not impossible the label itself may become unstable as more diverse laboratory practices and innovation processes emerge in proximate areas in the biosciences (Molyneux-Hodgson & Meyer 2009).

Regulating 'synbio'?

A notable feature of much of the policy discourse surrounding the emergence of synbio is what could be described as synbio exceptionalism (for interesting parallels to 'evidence based medicine' see discussion in Lipworth, Carter & Kerridge 2008). This is the idea particularly amongst promoters of synbio (but not exclusively) that the field is so novel that traditional models for regulation and professional structures of the sciences are no longer relevant and new models and professional ethos coinciding with the field's novelty need to be generated. Linked to this exceptionalism have been claims by some promoters that synbio represents a parallel to the revolution in IT of the 1980s and 1990s and that now in the 2010s the circumstances are 'ripe' for a biotech revolution (or a post-biotech era). These parallelisms frequently rely on rather idealistic histories of IT industries which emphasize their rapid growth, resistance to meaningful regulation, positive economic and social outcomes and the key roles played by creative entrepreneurial innovators and flexible intellectual property regimes. More contextually nuanced alternative histories of IT that acknowledge the importance of military investments and govern-

ment standard setting and corporate and utopian ideologies, are overlooked. IT metaphors have been a particular feature of some popular accounts of synbio emanating from the US and in the work of key synbio scientists such as Drew Endy and J. Craig Venter and influence terms used to describe various aspects of synbio innovations such as 'Open Wetware' and 'Hacker and Garage Biology'.

In testimony presented to a recent United States Congressional hearing, synbio scientist J. Craig Venter captures this mood well:

> I liken this to the early days of the electronics industry, where we have a number of design components and I have viewed now the 40 million genes, most of which have been discovered by my institute, as design components for the future and I do not think we can imagine all the discoveries. (Venter 2010)

Amongst organizations wary of the future promises of synbio such exceptionalism has not been so readily embraced, various NGOs such as the Canadian based ETC group have emphasized the continuities between synbio and biotech. Synbio is characterized as a simply more intensely commercialized and industrialized form of biotech. In places they have described it as 'biotech on steroids' with the potential for similar but potentially even more intense problems in terms of risk and IP (ETC 2007; Tucker & Zilinskas 2006). These groups in general terms have promoted the strengthening of traditional forms of regulation and the promotion of public debate in advance of the field's further development. In a variety of regulatory contexts in practice, existing patterns of regulation drawn from traditional biotech concerns fine tuned to fit into new contexts still prevail, aside from promotional or pejorative visions (Balmer & Martin 2008).

Many scientists involved in synbio have also been pro-active in promoting public awareness of the field, arguably with the aim of securing forms of minimal or self-regulation. Much of this effort has been justified in terms of avoiding what many bio-scientists perceive as the pitfalls of the recent history of GM regulation (Yearley 2009). Through showing a pro-active concern synbio scientists such as J. Craig Venter hope to build trust with the public and regulators (Garfinkel et.al. 2007; Venter 2010).

The pro-activity of such scientists has sometimes also been legitimated by synbio exceptionalist arguments which are deployed to imply the lack of relevance of traditional ELSI (Ethical, Legal and Social Implications) approaches. It should also be noted that like biotech more generally, different national contexts have seen these sorts of issues being framed with different emphases. For instance the promotional activities of synbio scientists have thus far been more obvious in the United States than in Europe with individual scientific personalities such as Venter playing a role. In the US there has also generally been more concern with bio-security, dual use and IP issues than has been the case in Europe, where broader environmental concerns have been more visible (Torgersen 2009).

The emphasis on synbio as revolutionary and exceptional and demanding new norms/practices etc. may well be overstated and understate continuities between past knowledge/practices and the lack of coherence of synbio at the current time. Despite this, the emergence of synbio exceptionalism and these calls for new forms of upstream engagement have attracted significant funding and constitute what may well mark an important trajectory in science studies research, which may persist even if synbio itself as an area of science does not fulfil its promise or diffuses into a variety of research fields or is absorbed back into more 'traditional' biotech.

In the wake of these 'consciousness raising' activities from scientists, science studies scholars and activists, various government agencies across Europe, the UK and the United States have mandated a variety of ELSI initiatives and public information programs. Whether such programs constitute real forms of anticipatory governance or fit into the realm of symbolic politics as participation rituals remains to be seen (Barben 2008 et. al.). Notable initiatives have included:

– *Europe*: SYNBIOSAFE established by the EU in Vienna to stimulate debate and provide information (Schmidt 2009).
– UK 4 research councils provided funding for 7 scientific synbio networks all requiring some ELSI (Lentzos 2009).
– US, NSF, SynBERC project, 'Human Practices' experiments (Rabinow 2009).

Whilst some of these initiatives such as SYNBIOSAFE appear to have largely worked within a fairly traditional communication model (which is no doubt part of its remit), perceptions of synbio exceptionalism would appear to have constituted a stronger influence on the framing of some of the UK and US initiatives in novel terms.

Typically (particularly in the case of the UK), discussions surrounding these initiatives have questioned whether traditional ELSI approaches focus excessively on responding to the consequences of innovation rather than actually shaping it (Lentzos 2009). In particular, there have been calls for 'upstream' engagement (i.e.: processes of regulation, governance and non-scientific input in the early foundational stages of a new scientific development or innovation) and collaboration between social scientists and synbio scientists linked to the construction of new professional structures and 'scientific norms'. Jane Calvert and Paul Martin have, for instance, argued the emergence of synbio provides an opportunity for a serious re-appraisal of what might be considered the appropriate meaning of collaboration by social scientists in 'scientific projects'. They suggest that it is important to move beyond imagining social scientists in upstream engagement as mere contributors. Contributors may be representatives of the public voice, brokers, translators or facilitators, but a true collaborator should have an involvement that can potentially influence the scientific knowledge that is produced:

> For a collaborator, the demand for social scientific input into debates about synthetic biology is a unique opportunity. The UK's research councils require an ELSI component in network proposals in synthetic biology and, although this could end up as a token contribution, it could also become a more genuinely collaborative exercise. There is an opportunity for authentic interdisciplinary work to take place that does not just follow the scientific research, but interacts with it. This is made more likely because social scientists are being involved in synthetic biology at the 'upstream' end, when the research is in its early stages. (Calvert & Martin 2009, 203)

In a similar, but perhaps more methodologically (although not politically) radical vein, Paul Rabinow has been involved in an ongoing 'post ELSI' experiment or 'Human Practices' initiative of embedding 'social scientists'

(not a terminology Rabinow would use) in a major synbio project titled SynBERC based at the University of California, Berkeley (Rabinow 2009).

These initiatives provide a timely opportunity to consider the strengths and weaknesses and different meanings that can be attached to the ideas of upstream engagement and collaboration. Clearly most practical initiatives in relation to synbio are in their infancy, especially in the case of the UK (Lentzos 2009). So it is important to acknowledge that the following commentary will mainly be based on considering general principles and scenarios, although at a later point it will offer a separate analysis of Rabinow's project as it has been running for long enough to provide the opportunity for more specific critical analysis.

Ups and downs of upstream engagement

Talking in terms of general principles, upstream engagement has been promoted in a large body of science studies literature, and by many theorists over many years, on a variety of often interrelated grounds, including that it:

– offers the opportunity for broader input to shape scientific knowledge and technological practices prior to them becoming crystallized or developing technological momentum. These concerns originally drawn from studies of the innovation process and social shaping of technology dovetail with numerous studies of scientific governance and public understanding of science, which have suggested that frequently attempts to incorporate public participation in scientific decision making happen too late to be of consequence as key issues have already been framed and decision making paths determined (Barben et.al. 2008; Mcnaghten, Kearns & Wynne 2005; Pidgeon 2007; Sterling 2005; Wilis & Wilsdon 2004).
– helps create new ways of thinking about emerging scientific/social problems that may not fit neatly within existing technocratic frames (Irwin 2008).

– constitutes a form of acknowledgement of the emergence of numerous modern techno-scientific activities which involve social and technical uncertainties and the creation and assessment of hybrid (socio-technical), contextualized forms of knowledge (e.g., 'post normal' or 'mode 2' science). Assessing such forms of knowledge involves mixtures of scientific and social considerations (Nowotny, Scott & Gibbons 2002; Ravetz 2006).
– encourages scientists to reflect on the ethical and political orientations of their work and align their self-interests with broader notions of social wellbeing (Rabinow 2009).

It should be noted that within this framework which promotes upstream engagement there have also been calls to ensure that it is 'true' to its rhetorical promise and involves substantial opportunities for genuine participation. Concerns have been raised that whilst more institutions involved in the governance of science are acknowledging the importance of 'upstream engagement', they are still working within traditional frameworks which inhibit its effectiveness (Barben et. al. 2008). It is in the context of these concerns that Calvert and Martins' and Rabinow's calls for more intense forms of 'upstream engagement' and collaboration can be located. Although it is worth noting that Rabinow, unlike the former, deliberately offers a departure from this literature by showing limited concern with 'public' upstream engagement or challenging the ways scientists may frame ELSI issues. This theme will be explored in more depth below.

Despite the broad support for the 'ideal' of upstream engagement in STS literature there are a number of questions that can be raised about its conceptual coherence and how far it really satisfies the aims of its advocates. It can be noted that advocates frequently fail to consider the following:

– The innovation processes is not linear and easy to predict. By failing to take this into account they offer 'compressed foresight' (Williams 2006) failing to acknowledge possible feedback loops, uncertainty, technological failures, and the possibility of knowledge creation at

multiple points of time and space. If less linear approaches are adopted then upstream engagement (assuming a weaker form of the metaphor can still survive) is only one of many places where social scientists, regulators, non-scientists can engage with science (Edmond & Mercer 2004; Mercer 2004).

– In scientific controversies there are frequently a diversity of scientific and social viewpoints and also diverse assemblages of social/scientific positions involving coalitions of scientists, activists, social scientists and attentive 'publics'(Irwin 2008). This means that in areas of unsettled science there may be multiple possible trajectories, multiple 'up-streams and down-streams' and multiple stakeholders. Attempts to institute upstream engagement may involve developing points of focus that are too narrow to allow meaningful engagement (Tait 2009).
– If pre-existing views are already polarized upstream engagement may unhelpfully amplify and consolidate disagreements unrepresentative of the fluidity of public opinion and political interests (Tait 2009).
– The limits of 'upstream' as a metaphor: Does it refer to time/place or key nodes/sites where knowledge is originated or 'stabilized'? (Mercer 2004; Edmond & Mercer 2004).
– Conflicts of interest and co-option are likely to arise in contexts of 'close' collaboration (Edmond & Mercer 2009).
– Normative orientations: Why engage upstream and on behalf of whom? Science is always experiencing upstream social engagement (Caudill 2009). Sometimes this may be of socially desirable/transparent kind, other times it may not. On what grounds should some groups be allowed to engage upstream and should it be at the expense of others?
– What type of expertise are social scientists likely to bring into collaborative interactions? For example, are social scientists likely to be able to offer 'contributory' expertise about the technical details of the topic at hand or 'referred' expertise: expertise about science more generally? The nature of social science expertise may well often be restricted to the former with a limited capacity to shape the content of specific knowledge claims (Collins & Evans 2002). Following this,

should scientists also demand to engage upstream in STS scholarship? (Tait 2009).

– Possibilities for meaningful upstream engagement and collaboration will be shaped by legal and regulatory cultures and political and financial interests. In some cases activists may dominate but in many others scientists and scientific institutions will be more politically powerful.

As noted above, whilst various networking and collaborative activities between social scientists and synbio scientists are being planned or are in their early days, Rabinow's Human Practices experiment at SynBERC offers an example of a project which has actually been running for a number of years. It is also reasonably accessible to the analyst as he has provided programmatic statements and ongoing reflective commentary on its successes and failures to date (although this may provide a slightly jaundiced view). Evaluating Rabinow's Human Practices experiment then, provides a useful mini-case study to reflect on the more general points noted above concerning the strengths and weaknesses of upstream engagement and collaboration.

Human Practices and SynBERC

SynBERC, established in 2006, is one of the most important synthetic biology projects in the United States. One of the requirements of NSF funding (the project also received support from numerous other sources of funding, notably from the Melinda and Bill Gates Foundation) was for SynBERC to contain an Ethical, Legal and Social Implications (ELSI) component. Originally this appeared to be proceeding along fairly traditional lines with workshops and deliberations on basic but pressing regulatory issues such as ways of inhibiting dual use, maintaining bio-security, generating appropriate IP laws and 'fine tuning' how these regulations should be developed and implemented. Quite early in SynBERC's existence these more traditional ELSI activities were nevertheless displaced by the introduction of the so-called 'Human Practices' initiative led by eminent

anthropologist/philosopher Paul Rabinow. 'Human Practices' formed one of four so called thrusts that made up the SynBERC project, the other three dealing with more technical aspects of the project. In very general terms, and for reasons that will be outlined below in more detail, it is not a completely straightforward matter to describe what Human Practices have involved in practical terms so far, although there have been activities such as the construction of a web site, commentaries and publications reflecting on the project itself, policy commentaries, regular meetings with natural scientists, and participation in constructing various synthetic biology teaching initiatives (Edmond & Mercer 2009). The absence of tangible plans, measurable interventions and outcomes, is in some ways consistent with Rabinow's philosophical rationale, which emphasizes emergence, novelty and that Human Practices should become embedded in SynBERC (synthetic biology itself) rather than work at a distance from it.

Rabinow's rationale

Rabinow emphasizes that the novelty of synbio knowledge and practices, require new normative orientations, and new forms of collaborations between scientists and human (social) scientists. In keeping with this emphasis on novelty, Rabinow 'avoids' reference to attitudes and strategies explored in more mainstream STS or traditional science policy literature, preferring 'classic' scholars such as John Dewey and Aristotle. From the former he emphasizes the need for 'experimental' approaches to be adopted to help articulate/frame 'socio-technical' problems and develop responses to them. In describing his aims he uses multiple neologisms, novel 'terms' of 'art', new meanings for traditional terminology and mixed metaphors, e.g.: anthropology of the contemporary, the collaboratory, pedagogy, flourishing, equipment and so on.

The main goals of Human Practices, following from Rabinow's recognition of the emergent qualities of synthetic biology and scepticism about traditional 'science and society' approaches, is for human scientists, through various processes of evaluation, facilitation, engagement and collaboration, to encourage SynBERC's bio-scientists to become highly reflective about their practices (these processes of reflection are described

under the heading of pedagogy). 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'. To provide an example of Rabinow's vocabulary he 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.
> (Rabinow 2009, 305)

In very ideal terms transposing this rationale to a potential problem area of synbio such as bio-security, Rabinow and his colleagues suggest that there is a need to develop a philosophy, to use one of their terms of art, of 'preparedness'. Rather than specify a range of regulations attempting to anticipate 'in advance' possible security problems, preparedness emphasizes the importance of the exposure of scientists to the appropriate Human Practices pedagogy which will facilitate their development of a capacity for reflection and perception of self-interests which will correspond with the social good (flourishing). Implicitly the greater autonomy afforded to such morally informed scientists also allows for the types of flexibility, vision and responsiveness that will be needed to cope with the unpredictable but ultimately positive futures offered by synthetic biology (Rabinow, Bennett & Stavrianakis 2005).

Human Practices in practice?

Before considering what Human Practices has achieved to date, it is worth first considering the following questions: What sort of engagement is likely to emerge? What are the likely impacts of such engagements? And what, if anything, do such engagements offer beyond more traditional forms of regulation?

A key feature of Human Practices, as noted above, is Rabinow's reluctance to map in advance detail what he hopes engagement to achieve. His vocabulary is opaque featuring numerous metaphors and neologisms designed to capture emerging and uncertain relationships, at best there is a notion of an association between engagement and mutual flourishing. This approach has the strength of not prefiguring how various forms of collaboration and engagement might evolve in practical settings where there are the possibilities of unexpected contingencies and opportunities. Having a strong set of ethical/social science precepts for instance might close off innovative ways of understanding new practices, processes, products. For example, arguments are often made that one of the challenges frequently encountered in intellectual property issues is that traditional conceptions about the nature of what can be owned and the consequences of ownership are frequently inapplicable to the kinds of 'technical' objects that inhabit the modern world. Entering into these debates with traditional conceptions may often be quite unhelpful.

The lack of any explicit or detailed normative vision is nevertheless problematic in a variety of ways. It should be remembered that most calls for upstream engagement or collaboration between social scientists and scientists have some kind of vision of participatory democracy or some specific aims to incorporate wider societal concerns into scientific projects. Such approaches also normally presume that non-scientists may offer ways of framing issues in different ways to scientists. In Rabinow's model the social scientist does not have a clear professional identity (Gieryn 1998) or bring into the context of collaboration anything to identify why they are there. Rabinow, perhaps as a reflection of his anthropological orientation, seems to conflate being present with being engaged. There appears to be an assumption that synbio scientists will discover their true 'good' (socially responsible) inner scientist through the mere association with Human Practices (social scientists). A lack of critical or normative stance which assumes a ready alignment between scientists' perceptions of the social good and what is actually good also implicitly homogenizes science and overlooks the possibility that scientists may have different interests, different visions, differing ethical standpoints, and arrive at different views even after reflection invited by engaging with Human Practices.

It is also worth noting that unless 'upstream engagement and collaboration' is understood with at least some explicit ELSI reference points there is very little to differentiate Human Practices from the variety of other forms of informal 'upstream (social) engagements' that are already part of SynBERC (Caudill 2009). For example, SynBERC already involves the input of administrators, financial advisors and scientists who are also entrepreneurs influenced by financial and personal interests. In short, SynBERC's scientists are already exposed to, and shaped by, non-scientific influences, so if Human Practices has no 'agenda' other than being present, what are they actually offering of any consequence?

Another feature of Rabinow's vision is for Human Practices to have equivalent status to the other strands of SynBERC, as one of 4 strands of activity integral to the project. Whilst there are obvious hypothetical advantages of being 'embedded' in the project in terms of access to people, information and timeliness (Rabinow & Stavrianakis 2009), there are also a number of fairly obvious liabilities and limitations of such 'tight coupling'. In particular, there are obvious conflicts of interest in such 'embedded' arrangements as SynBERC. It is hard to imagine sustained opposition by Human Practices to any given project and collaboration still being sustainable. This also highlights a more general challenge of many forms of collaboration, of co-option, particularly when one party is politically much weaker (Edmond & Mercer 2009).

There are also interesting issues raised by power/knowledge relations involved in collaboration in the context of the distribution of intellectual property and financial benefits (and possible liabilities) emanating from the project. Scientists increasingly (and especially in fields such as synbio) have financial stakes in their work. It is interesting to speculate on what financial share of profits from SynBERC would (will?) flow to the Human Practices strand of the project and how the contributions of Human Practices will be measured. Similar issues arise in potential IP disputes. In such contexts conflict of interest issues also re-appear. Human Practices resistance to or critique of a particular project (if Human Practice contributions were to be acknowledged as contributing to IP) might involve forgoing significant financial rewards (Edmond & Mercer 2009).

The question of how to measure the contributions of Human Practices (social scientists) to the 'content' of synbio science also resonates with some broader, longer standing theoretical issues in the sociology of scientific knowledge surrounding theories of expertise and the public understanding of science. Rabinow's embedded model of collaboration implies Human Practices aspire to go beyond merely acquiring 'native competence' (i.e., the ability to comment on synbio science) but actually to develop, to use Collins' terminology, contributory expertise (Collins & Evans 2002). This raises questions about whether it is plausible to expect that Human Scientists, through the kinds of engagements with bio-scientists envisaged by Rabinow, would have the opportunity/capacity to develop such deeper forms of expertise: Whilst most science studies scholars acknowledge to varying degrees that scientific knowledge is socially constructed, it is normally also acknowledged that this is a historically contingent process involving tacit knowledge, skills and professional training.

Reflecting on collaboration and upstream engagement

Whilst the Human Practices experiment appears to have made some progress in satisfying at least some of the basic pre-conditions for collaboration and upstream engagement (for example, it has avoided framing issues in traditional binary terms of science vs. society, practitioners are embedded in close proximity to laboratories and scientists and are involved in some sense in the early phases of technological innovation), it would appear to have failed in a significant number of others.

Primarily the project lacks evidence of reflection on the following issues: (a) the specific political context in which collaboration is likely to evolve; (b) how might being embedded upstream influence the capacity to offer critique, and (c) for what normative/political purposes is collaboration taking place, or why 'engage upstream' to start with and on whose behalf. These problems are intensified by the vagueness of Rabinow's aims and lack of creating a clear professional self-image/identity for Human Practices (social scientists) (Edmond & Mercer 2009). Whilst Rabinow could

defend the open-endedness of his vision in terms that it reflects the emergent nature of synbio, it is easy to imagine that scientists engaged in SynBERC's other more 'technical' thrusts may find it unclear what their collaboration with Human Practices might actually involve. Interestingly, in a number of commentaries available at the time of writing, Rabinow in fact concedes that something like this may be occurring. He has voiced his frustration that Human Practices have so far largely been marginalized and frequently treated as little more than SynBERC's PR unit. It would appear that aside from Rabinow's idealism, SynBERC scientists have encountered difficulties appreciating/understanding/caring about the Human Practices vision (Edmond & Mercer 2009; Rabinow 2008). It is not impossible that the Human Practices experiment will continue to evolve and encourage new forms of collaboration between scientists and social scientists, ways of thinking about ethnography and performing laboratory studies, and models for educating future scientists. What seems less likely is that the experiment, unless radically re-thought, will contribute much to producing publicly accountable science, offer a realistic alternative to traditional ELSI concerns to regulating synbio, or contribute anything of substance to experiments in upstream engagement.

As noted earlier, most experiments with upstream engagement and collaboration in synbio are in their infancy. So hopefully there is time for a more mature discourse on upstream engagement to emerge that balances images of synbio's exceptionalism and the need for novel sociological approaches with a more critical orientation that acknowledges the need to clearly articulate what is aspired to by engaging and collaborating with synbio scientists.

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