Synthetic Biology as Social Construct: Imaginations as Accountable Material Democratic Social Formations?

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I INTRODUCTION

This brief discussion paper attempts to provide some productive ideas for a new and timely interdisciplinary research program being considered by US NSF (but in principle of value and relevance more generally) on societal aspects of synthetic biology (henceforth, 'synbio'). I start with the question: what do we mean by social research on synthetic biology as a major field of modern technoscience? Here, one key point I need to make at the outset, taken for granted by most (but by no means all) scholars in my own field of Science and Technology Studies or Sociology of Scientific Knowledge (STS-SSK), is that social research in such technoscientific fields has to include a sociological, historical and in-part philosophical understanding of the technoscientific *knowledge-cultures* which define the field of synbio (or any other technoscientific domain). I return to what this means for a social sciences/humanities (SSH) research agenda on synbio in Section III below. However we should immediately note that this has to involve much more than only attempts to identify and/or anticipate downstream 'social impacts' of synbio, but also has to include a focus on upstream social-political-economic-cultural questions. This is a different SSH research agenda from the downstream one; and it is not a replacement, but an additional, often neglected, agenda.

One further reason that an SSH research approach has to move upstream and into the insides of technoscientific knowledge-cultures from the more usual downstream and external presumptions and framings, concerns the recognized importance of understanding public responses to the technoscience concerned (again, this is a general matter, for any technoscience). This is the point (Wynne, 2007, 2014) that we cannot begin to understand those public responses, until we also first investigate: what is the technoscience which we suppose those publics are experiencing, and to which we assume they are responding? This is a specifically STS-SSK approach to public attitudes and responses, and is different from most mainstream social scientific approaches such as social psychology or psychometrics, where implicitly the 'black-box' of the technoscientific knowledge-culture, including its modes of promotion and legitimation to society, funders, etc., is left unopened and unproblematized. This important 'reflex' lacuna was pointed out in the earliest days of 'public understanding of science' research (Wynne, 1992), but it still needs to be addressed. Thus-far it is only approaches informed by STS-SSK which are equipped, and willing, to do this.

In the next section I describe some premises which I identify as informing dominant institutional (eg policy for synbio, as well as synbio scientific) discourses in this domain, and raise some problems with those typically unquestioned or unproblematized premises and promises. I then attempt to delineate different and more realistic starting points from which such a research program could be designed and developed, and worked into practice as an interdisciplinary collective learning program, in government, industry, and university research and teaching. This is necessary brush-clearing for our main focus, which is on a productive SSH research agenda for synbio in all its variants.

II UNEARTHING HIDDEN HUMAN, AND SOCIAL, DIMENSIONS

If as I assert, there are human and social, and possibly normative dimensions of an important R&D&I field like synbio which remain concealed or unstated (not necessarily deliberately, but also inadvertently), this has important consequences for what we hope to be an accountably informed and reflexively developing democracy. The conventional downstream social sciences research approach, by framing appropriate agendas as about social impacts, even if *anticipating* future social impacts, effectively describes the upstream technoscientific knowledge-culture as devoid of any social or human dimensions. In effect therefore it says that there are no social or human questions here, and that these only arise once social impacts begin to be generated, directly or indirectly. Even regulatory and governance frameworks which 'gate-keep' the technoscientific R&D into (usually) commercial societal innovations, frame these stages of innovation as 'science-only', through risk assessment.

Much STS has challenged this dominant institutional boundary-drawing, between 'science' and 'society', which is also a drawing of boundaries of control, and responsibility. As well as being in states of change themselves (which needs research), these also vary between governance regimes, or national policy cultures (Jasanoff, 1987). The sociology and political economy of these continually emergent processes remains an important object for policy-salient scholarly SSH research (see Section III). These also require synthetic biology as science and engineering, to adopt different approaches and indeed new self-definitions from normal ones, as well as to seek new relationships with diverse new stakeholders, who might help redefine, through policy, funder and public, and internal technoscientific debate, about the proper democratic purposes and priorities for synbio R&D&I (eg Schuurbiers & Fisher, 2009; range of synbio relations with/roles for social sciences: Synberc (Rabinow et al), IC-KCL (Marris), STIR, Fisher *et al*, BBSRC 2010)

A further domain of technoscientific culture which remains too-little researched, for synbio as well as for other fields, concerns the combination of the political-economy of technoscientific knowledge with that of symbolic action (Edelman, 1972). The Lancaster University Cesagen genomics and society centre coined the term, "the political economy of promise", to describe the ways in which under the intense political economic pressures and expectations following the huge public (and private) funding of the 1990 Human Genome Research Programme, genomics research in particular has become used to projecting spectacularly ambitious but equally spectacularly *questionable* – and with the benefits of hindsight now to evaluate those promises for their delivery or failure to deliver – promises of extravagant social benefits which the R&D will provide. The point is that such promises have falsified themselves substantively and repeatedly, yet as Waterton *et al* (2013) have shown for the salvationary promises of DNA Barcoding of global biodiversity, such promises, crucial for persuasion and big-funding, appear to have little meaning for the credibility of the science making those promises – except paradoxically as a basis for articulating another maybe more extravagant promise to society and its funders, from the ('failed'?/'successful'?) technoscience. Implicitly here, technoscientific actors' imaginaries of future outcomes and societal benefits (thus also, selectively, of societal priority needs, as well as of the appropriate technical-social-economic means of meeting these) from their research are being allowed to intervene in and change society, with no accountability to the society which is funding, and being reshaped by, that technoscientific work. Thus a further upstream dimension of synbio emerges as given in Section III, to be in need of SSH research, with synbio technoscientists' in collaboration if possible

III SOME PRPOSALS FOR SYNBIO SSH RESEARCH

The brief discussion above indicates some interesting and important, as well as original and path-finding, SSH research agendas, most of which would also need thoroughly prepared interdisciplinary collaboration between SSH and technoscientific researchers, and including commercial, funding, and policy actors too, as appropriate.

(i) What is "Synthetic Biology"?
This research question is raised because there is actually so much confusion and inconsistency about the answer. Moreover, this inconsistency is not something which can be pinned only upon ignorant publics, NGOs, or media, lacking adequate information though they usually are. The synbio technoscientists who are often mistakenly assumed to be fully informed about their own field and any risks which it may carry, should also be investigated by technically informed SSH scholars, as to their own definitions and understandings of synbio, and these analyzed for their inconsistencies, their boundaries, and their implicit definition of the natural and the human. One might well expect these to be systematically differentiated within the synbio technoscientific field in a similar way to those of genomics-related scientists for their own variable understandings of their basic scientific objects, the 'gene' and the 'genome' (Stotz, Griffiths, & Knight, 2004; Griffiths & Stotz, 2006).

(ii) However the point of asking this question about synbio as a field of technoscientific discourse-practices (as was true of the research on the 'gene' question too) is not to assume a singular objective answer and proceed to find and communicate 'the' true definition. It is to show the variability of expert synbio practitioner understandings of what they are doing, and of what they believe or claim synbio can do for society. Many such definitions of synbio are straightforwardly conventional biotechnological research. Others range through to completely unprecedented synthetic DNA or novel DNA equivalents whose biological viability, let alone functional value for society is claimed or promised, but untested. In addition the epistemic shift towards the principle as expressed by several leading synbio spokespersons, that to know any natural process, we have to build it and make it work (Dupuy, 2007), has provided legitimation for potentially limitless experimental interventions into society (not to mention, nature) with little realistic prior regulatory assessment in the public interest. This state of affairs suggests an important research agenda concerned to understand what synbio practitioners understand their technoscientific field to be, and on what epistemic foundations they understand it to rest – for example do they believe that government regulation is founded in risk assessment? Is this adequate? How do they think that risk assessment can be done, when the technological objects supposedly subject to that risk assessment, cannot even be precisely defined, as putative causal agents of supposedly definable risks? How does such unfounded risk assessment deal with 'scientific uncertainties' (contingencies, ignorance, ambiguity) beyond known consequences of known likelihoods? What further governance questions or appraisal processes might be necessary to address such lacunae, and how could more upstream anticipatory processes be defined, tested, and institutionalized as part of the governance of such emergent technosciences? How might these be developed in conjunction with the new governance approaches to responsible research and innovation (RRI)?

(iii) Given the intense promise-based legitimatory discourses of synbio, in face of the very modest actual fulfilment of these justificatory promises and the huge funding invested in the field, how could these promises be included in the agenda of appraisal for governance purposes for such technosciences? How do *internal* technical failures or inadequacies of the technoscience come to be defined as failures caused by external factors such as public ignorance and inability to treat such promises of social benefits as if real evidence-based achievements as distinct from functional myths (Ezrahi, 2013) of synbio and its supposed achievements and societal contributions?

(iv) how are the technosocial imaginaries and promises formed, on which synbio is fueled? with what combinations of internal technical and external socioeconomic factors? What practical epistemic status do such promises and imaginaries have with technoscientists, funders, policy actors, NGOs, and other stakeholders such as publics? How are these evaluated by this same range of actors, once their promised outcomes are open to evaluation by those affected? What would it take to include these promises as objects of regulatory appraisal for the technology or any specific case of synbio innovation? And on what arguments would this be resisted, by which actors? What further dimensions beyond case-by-case scientific appraisal are required for adequate anticipatory governance of synbio? Why is there no such 'upstream' debate even begun, let alone any institutional experimentation with forms of anticipatory appraisal of such promises, when these promises raise such manifestly important societal questions?

(v) When technoscientific synbio experts state for persuasion purposes that their innovations 'work', what does this mean? And how might this be interpreted in different contexts of relevance, for example in laboratory situations, regulatory arenas, funding proposals, media publicity, or in public engagement processes? For example 'working' for lab situations, might mean bare reproductive viability (like DNA replication rather than sexual reproduction), whereas for society it might mean more, such as being functionally successful for purposes of introduction of new useful traits into plants or other organisms. Are confusions traceable in such crucial languages of synbio's claims to 'work' for society? How do such confusions confound adequate societal appraisal of and decision-making for synbio, and how could they be better controlled?

(vi) There are a range of research questions for synbio, in connection with the induction of what Schuurbers and Fisher (2011) call second-order reflexivity of the field, in dialogue with appropriate stakeholders and publics.

(vii) The same is true of public and other stakeholder dialogues with synbio (BBSRC, 2010), an involvement which could be designed as 'upstream' engagement about the driving purposes, and alternatives to, and not only consequences of, synbio research. Who is excluded from defining R&D aims, imaginaries, and social needs for synbio, which could productively direct it better towards meeting social needs and aims?

IV CONCLUSIONS

Probably the most important principle for defining a beneficial SSH research agenda for synbio, is to recognize the historically unprecedented intensity of the promissory political economy which drives and selectively shapes synbio R&D&I. This heralds a shift of epistemic principles, in which the defining importance of the ambitious promises that

constitute the field are recognized as if they were evidence-based when they cannot in principle be evidence-based. These key promises could then be subjected to a novel and expressly experimental process of regular institutional appraisal to inform policy decisions, in regulation of innovations in this field. This becomes especially important not only as a basis of repairing or at least limiting public mistrust, but also to compensate for the fact that synbio objects are elusive as objects for risk assessment or other appraisal methods which rely upon, and effectively claim, prediction of undesired consequences.

It is an as-yet unacknowledged predicament – even a contradiction - for such a dynamic, variable, flexible and distributed domain of technoscience, that one cannot seriously pretend to predict causal consequences, if one cannot even define precisely what is the technology in question which is causal agent of its consequences. Thus if this key, almost the only regulatory/governance instrument is rendered moribund, research to identify, develop and test an appropriate functional portfolio of alternative instruments becomes a vital SSH synbio research agenda.

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