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Opening up the future(s) of synthetic biology

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ABSTRACT

Much of the discussion surrounding synthetic biology involves some degree of speculation about the future. This paper reports on two workshops we held with the aim of 'opening up' and exploring possible futures for synthetic biology, one at the Synthetic Biology 4.0 conference (Hong Kong, October 2008) and the other at the BioSysBio meeting (Cambridge, UK, March 2009). We developed an interactive 'causes and consequences' exercise for these workshops, with the aim of creating a space for members of the synthetic biology community to discuss issues about the future of the field that they might not regularly explore in their daily work. We analyse the outputs and discussions from these workshops in the light of three key themes: the connections between social and technical issues in synthetic biology, the roles and responsibilities of synthetic biologists in shaping possible futures for the field, and the suitability of this method for opening up discussions about the future.

1. Introduction

Synthetic biology is a field of research concerned with using engineering principles to design biological systems. The origins of this approach can arguably be traced as far back as the early twentieth century [1,2], but over the past 10–15 years a school of synthetic biology concerned particularly with 'parts-based' genetic engineering has been growing rapidly (e.g. [3,4]). New teaching and research initiatives, communal repositories of biological parts and tools, and dedicated conferences and journal publications, are all being developed to advance this field. But securing support and resources for any new discipline is no trivial endeavour. Convincing others that they should invest their time and/or money often relies on making predictions about the potential payoff of such investments. Expectations about the possible future of a technology are also strategically important for generating enthusiasm and momentum within a research community. Indeed, much of the current discussion and interest in synthetic biology revolves around its *potential* — the potential of this technology for innovation, profit, misuse, and so on. The number of new and imaginative initiatives being developed by the synthetic biology community[2] suggests that its members are guided by a strong vision of the potential and the future of this field, one that differs somewhat from traditional life science disciplines.

Expectations about the future are not just important for generating support and momentum within a scientific research community, they can also be highly influential when it comes to decisions about the funding and regulation of particular technologies. Forecasting and analysing the future is an increasingly important part of science policy, and a number of

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[2] Such initiatives include the development of a Registry of Standard Biological Parts (http://www.partsregistry.org/), an undergraduate competition designed to help populate the Registry with biological parts (the International Genetically Engineered Machine or iGEM competition, http://2012.igem.org/), and an intellectual property framework for sharing biological parts (the BioBrick Public Agreement, https://biobricks.org/bpa/). Websites last accessed 01.03.13.

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approaches are routinely used to map, guide and intervene in possible futures (see Section 1.1). As well as policymakers, sociologists of science are also interested in futures, expectations and technological potential, trying to understand how visions of the future might influence scientific cultures, practices and knowledge production in the present. The 'sociology of expectations' in particular is concerned with how technologies, industries, and ethical, legal and social issues are related to visions of the future [5]. The aim of such research is "to engage with the future as an analytical object, and not simply a neutral temporal space into which objective expectations can be projected" ([6], p. 4). Indeed, research in the sociology of expectations suggests that discussion of the future is not idle speculation, but instead has real effects. Actions in the present are made legitimate by promises about the future [6]. Statements about expectations can mobilize funds and attention, and reduce uncertainty [7]. This makes promises (and the act of promising) essential characteristics of all new scientific and technological fields [8,9]. Furthermore, research shows that the most radical claims about the future are likely to be found where there are *new* networks and activities [6]. This is because new fields "often require an incredibly visionary momentum in order to command investment and collaboration" ([10], p. 11).

The work we present here is an exercise designed to open up discussion about possible futures for synthetic biology. We are science and technology studies (STS) researchers who have been engaging with the synthetic biology research and policy communities since 2007[3]. We believe that one of the core contributions that a social science discipline like STS might make to emerging technologies such as synthetic biology is to 'open up' and draw attention to alternative possibilities for the future of the field [11]. This is because STS studies the plural and socially situated nature of knowledge claims, and in doing so reveals "inherent indeterminacies, contingencies, or capacities for agency" ([11], p. 279) in technological development. 'Opening up' from this perspective involves drawing attention to the often implicit framing conditions and assumptions that underlie discussions of the future, and to the interconnections between social and technical choices. This can enable new questions to be asked, neglected issues to be addressed, and alternative technological pathways to be explored [11].

Our aims in relation to this paper have been three-fold, two largely process-oriented and one more concerned with content. First, we wanted to draw the synthetic biology research community (including natural scientists, engineers, and social scientists) into thinking about and discussing different possible futures for their field. Second, we wanted to develop a flexible and lightweight methodology for beginning such conversations, in a style and format suited to the community we work with. And third, we wanted to explore how synthetic biologists imagine and understand different possible futures for their field, and the ways in which they connect the technical and social dimensions of the discipline they are creating.

1.1. Studying the future: foresight, scenarios and other methods

At a policy level, one of the better-known approaches to engaging with the future is through the use of foresight exercises. These often use methods such as roadmapping, forecasting, and modelling. Foresight exercises are typically designed to develop recommendations that feed into policy discussions and decision-making[4], and they remain a popular tool for European science policymakers[5]. However, there is an underlying tendency in many foresight exercises to presume that "development trajectories are stable and that the social implications of a technology are patterned into a technology at the outset" ([12], p. 336). Regardless of exactly which methods are used, Selin suggests that foresight exercises inevitably involve "a movement from open-ended complexity to simplicity" and "a radical constriction of variables" ([13], p. 1888). This sort of linear, 'essentialist' view of technological innovation that may be built into foresight exercises can project the future as largely determinate and imminent. This stands in contrast to a large body of empirical social science research that points to "the unpredictability, and indeed serendipity of social and technical outcomes" ([12], p. 329)[6].

Initiatives that are more interested in uncertainties and contingencies in different technological futures often rely on methods such as scenario-building and horizon-scanning. At least one detailed scenario-building exercise has already been undertaken for synthetic biology [14]. The Woodrow Wilson Center's Foresight and Governance Project has conducted an exercise to study the policy implications of synthetic biology as well as its potential benefits and possible harmful effects[7]. The EU TESSY initiative (Towards a European Strategy for Synthetic Biology, 2007–2008) had a roadmapping component[8]. A Synthetic Biology Roadmap for the UK was also published in 2012 [15]. This roadmap outlines the conditions required for the development of synthetic biology in the UK, and addresses issues of responsible research and innovation.

The interactive 'futures' exercise we have developed and tested does not fall neatly into either traditional foresight or scenario-based initiatives. Rather, it has different founding assumptions that are more closely aligned with social science

[3] Over this period our engagement with synthetic biology and synthetic biologists has taken many forms: we have attended synthetic biology conferences and meetings (as observers and speakers), we are co-investigators on synthetic biology grants with scientists and engineers, we are advisors and teachers on undergraduate and graduate synthetic biology pedagogical initiatives, we participate in public engagement exercises on synthetic biology, we sit on policy advisory bodies relating to synthetic biology, and so on. We are in part ethnographers but clearly also participants in the making of this field.

[4] UK Government Chief Scientific Adviser John Beddington describes the aim of the UK Foresight programme as "to bridge the gap in policy making between the short and the long term" (http://www.bis.gov.uk/foresight; last accessed 01.03.13).

[5] See for example the 2011–2012 European Commission foresight project on 'innovation futures' (http://www.innovation-futures.org/; last accessed 01.03.13).

[6] To cite a frequently quoted example, who would have predicted that lasers would find uses in medical applications and DVD technology?

[7] http://www.synbioproject.org/(last accessed 01.03.13).

[8] http://www.tessy-europe.eu/index.html (last accessed 01.03.13).