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Taking Roles in Interdisciplinary Collaborations: Reflections on Working in Post-ELSI Spaces in the UK Synthetic Biology Community

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Based on criticism of the "ethical, legal and social implications" (ELSI) paradigm, researchers in science and technology studies (STS) have begun to create and move into "post-ELSI" spaces. In this paper, we pool our experiences of working towards collaborative practices with colleagues in engineering and science disciplines in the field of synthetic biology. We identify a number of different roles that we have taken, been assumed to take, or have had foisted upon us as we have sought to develop post-ELSI practices. We argue that the post-ELSI situation is characterised by the demands placed on STS researchers and other social scientists to fluctuate between roles as contexts shift in terms of power relations, affective tenor, and across space and over time. This leads us to posit four orientations for post-ELSI collaborative practices that could help establish more fruitful negotiations around these roles.

Keywords: ELSI, post-ELSI, synthetic biology, collaboration, collaborative turn, interdisciplinarity

Introduction

When we open the black box of techno–science – in areas such as synthetic biology, nanotechnology and the life sciences – we see not only practices, materials, engineers and natural scientists, but also social scientists of various kinds, as well as ethicists, policy makers, public engagement practitioners, science communicators, designers, lawyers and regulators. This sociotechnical gumbo is characteristic of the current mixture of well-established and emerging practices of governing science.

Researchers in science and technology studies (STS) are often offered roles in technical projects and as part of scientific research centres, especially in new and emerging fields like synthetic biology and nanotechnology, as well as in environmental and health sciences. The

ways in which STS and other social science scholars are invited into these spaces, and the practices through which such interdisciplinary projects are enacted, have begun to shift. For example, STS researchers have begun working towards more collaborative relations. This paper emerges from our collective experiences in the UK context of being invited to be part of synthetic biology research projects and of how we sought to take more coproductive and collaborative roles in this context.

Novel technosciences like synthetic biology are presented as having huge potential to tackle global challenges but are also understood to present a number of associated "implications." This kind of framing of knowledge making and innovation practices became labelled as the "ethical, legal and social implications" (ELSI) programme. Although it is not explicit, the focus of ELSI is typically on the potential for *negative* implications. Policy arguments concerning the value of involving social scientists and conducting public engagement and dialogue events follow naturally from this "ELSIfication" (López & Lunau, 2012; Marris, 2015; Williams, 2006) and social scientists are often positioned as being responsible for the identification and remediation of potential negative downstream consequences of science. The conclusion that is drawn is that having a social scientist on board will produce public acceptability, improve the competitiveness of grant applications and satisfy ELSI requirements of research funders.

As we describe in more detail in the following section, STS scholars as well as other social scientists have identified a number of problems with the ELSI programme, including the emphasis it tends to place on a simplified, linear model of innovation, the attention given to the outcomes of research and innovation

over practices, the assumption that it is easy to classify outcomes as "negative" or "positive", and the distinction between "science" and "society" that it continues to embed. Such dissatisfaction with ELSI has led to the development of a range of more or less explicitly "post-ELSI" approaches to the work of social science in such interdisciplinary contexts. Such work often emphasises the need for deeper collaboration, interdisciplinarity, co-production of knowledge, upstream (or mid-stream) engagement, and real-time technology assessment. In this regard, once inside technoscience – even if invited in through the door of ELSI – STS researchers often seek to negotiate more productive and substantive positions.

However, concerns have arisen that as STS scholars have become more commonplace in sociotechnical fields we have lost our productive critical capacity. There are worries that we have become unable to say "no" to technoscience or to be critical when working with natural scientists and engineers (Nordmann & Schwarz, 2010). Invitations to engage in discussions of the future of technosciences presuppose that the technology will emerge and will necessarily have positive outcomes. At the same time, there are concerns that if we emphasise an "ethics of suspicion" (Fortun, 2005), distrust and antagonism, we are left unable to engage with the often effervescent hubris of promises about future technologies except through the prism of resentment and criticism. However, reflections on our positions within technoscience have often paid little attention to the actual dynamics of these relationships, so that whilst some of the ontological and epistemological challenges of different forms of interdisciplinarity have been mapped (Barry et al., 2008) we have only a few examples of what it is like to work day-

to-day in these spaces (Balmer et al., 2016; Fitzgerald et al., 2014; Rabinow & Bennett, 2012).

In this paper we contribute to filling this gap by reflecting collectively on some of the roles we have taken within the UK synthetic biology landscape. Synthetic biology is an excellent case for such reflections because it is a field in which novel practices of governance are very much entangled with questions about the role of social sciences in relation to the natural sciences and engineering.

This paper emerges from our sharing of experiences with each other and a number of other actors during an ESRC Seminar Series on "Synthetic Biology and the Social Sciences" that ran between 2008 and 2011 (for further details see http://www.genomicsnetwork.ac.uk/seminarseries/). We have continued to meet to discuss our experiences over the subsequent 4 years. We pool our experiences of and reflections on interactions with natural scientists and engineers in synthetic biology – collectively more than 45 researcher years of entanglement – across a range of contexts involving different types of practice, including undergraduate teaching, writing collaborative grant proposals, contributing to the design and implementation of experiments, conducting laboratory ethnographies, and participating in policy forums.

Although the focus of our reflections here concerns our collective involvement in synthetic biology collaboration in the UK, our observations have broader relevance. The collaborative spaces that characterise current work in synthetic biology are, we argue, indicative of an emergent mode of social scientific collaboration apparent across the acad–emy. For example, there are institutionally mandated forms of collaboration around nanotechnology in the US and in Europe

(Macnaghten et al., 2005). Ambitious programmes of collaboration are also being developed around climate change, Earth Systems Governance, global change research (Costanza et al., 2012; Hackmann & St. Clair, 2012) and global health research (Molyneux & Geissler, 2008). Moreover, novel forms of collaboration around neuroscience have recently begun to emerge (Fitzgerald & Callard, 2014; Fitzgerald et al., 2014; Rose, 2013). These developments have led some to proclaim the emergence of a "collaborative turn" in humanities and social science scholarship (Fitzgerald et al., 2014). Ongoing shifts in governance and the position of STS in sociotechnical knowledge production have helped to generate an increasingly distinct area of scholarly discussion around collaboration and STS, interdisciplinary entanglements and integration. It is our aim to contribute to this discussion here.

First, we briefly review the emergence and spread of ELSI programmes and examine some of the characteristic discontents that have developed in STS regarding this consolidation, and that point to the emergence of a "post-ELSI" set of practices. We identify a number of different roles that we have taken, been assumed to take, or have had foisted upon us as we have sought to move into post-ELSI spaces. We present these mid-level descriptions alongside ethnographic vignettes from individual experiences of working in synthetic biology to exemplify some of the key elements of these roles. We then argue that the post-ELSI situation is characterised by the demands placed on STS researchers and other social scientists to fluctuate between roles as contexts shift in terms of power relations, affective tenor, and across space and over time. From our consideration of these roles we briefly posit four possible orientations to post-ELSI

collaborative practices that might help in the active negotiation of these movements, both towards post-ELSI spaces and from role to role. We conclude that there is a lasting legacy of ELSI logics and practices that remains obdurate, but nonetheless that there is hope for the future of co-productive collaborative methodologies.

ELSI, its Discontents and the Emergence of Post-ELSI Programmes

ELSI emerged as a programmatic element of the Human Genome Project (HGP) and was thus structurally linked to the development of an ambitious state-sanctioned research effort (Jasanoff, 2007). It was connected to an earlier set of social conflicts over the risks associated with science and technology (for example around pesticides and nuclear technologies) and a concern that the HGP would generate similar controversies. The primary aim of the ELSI project was to mitigate the adverse effects of biotechnology, and thereby ensure that the HGP would be successful, in light of anticipated conflicts. Critically the ELSI programme also acted as a funding mechanism for dedicated research on societal dimensions of biotechnology with between 3–5% of HGP research funding dedicated to ELSI initiatives (Fisher, 2005). More broadly, ELSI research practices have been increasingly folded into what has been referred to as the "new governance of science" (Hagendijk & Irwin, 2006; Irwin, 2006; Kearnes, 2010) and the "Mode 2 knowledge economy" (Gibbons et al., 1994). The emphasis on knowledge production geared towards industrial application and the use of public deliberation to ensure the legitimacy of research agendas has helped to consolidate a dual commitment to "sound science" on the one hand and to social

and ethical analysis combined with public engagement on the other (Irwin, 2006). In practice, institutional commitments to ELSI research have also been critical in consolidating research groupings in both the social science and humanities, particularly bioethics, that generally take as their starting point the possible adverse "implications" of technology and the ameliorative role of ELSI approaches (see Fisher, 2005 and Williams, 2006 for further discussion). This arrangement continues to underwrite notions of transparency and accountability in contemporary techno-politics, both as a mark of good neo-liberal governance (Rose, 1999; Lezaun & Soneryd, 2007) and as a conscious performance of accountability and authenticity in technological politics (Brown & Michael, 2002; Doubleday, 2004, 2007).

A significant additional factor in the institutional support for the incorporation of social science research and public engagement initiatives into novel technological programmes is the commonplace assumption that the visceral public controversies that surrounded the development of genetically modified crops and civil nuclear power systems were precipitated by broadly "unscientific" public concerns (Wynne, 2006). This deficit model approach underscores commitments to science communication and public engagement alongside the integration of ELSI research into the process of technological development, in areas such as nanotechnology, synthetic biology, neuroscience and so forth. In UK synthetic biology in particular, the "GM debate" was a forceful repertoire, with concerns regularly expressed by research funders and scientists that synthetic biology could become the "next GM", and that the involvement of social scientists would help to prevent this (Marris, 2015). More broadly, there is a conviction that

synthetic biology raises important ethical, legal and social "issues", demonstrated by the large number of reports written on the field – 39 between 2004 and 2011 alone (Zhang et al., 2011). In this regard, ELSI has been both a set of practices used by social scientists but also a logic and political rhetoric adopted by governance actors, scientists, engineers and others to articulate the roles that social scientists can or should occupy within technoscience.

STS researchers, other academic communities, campaign groups and NGOs have all expressed discontent with the ELSI framework, but we focus here on the ways in which ELSI has been understood to limit academic collaborations. Concerns about the development of a commonly accepted policy discourse regarding the early involvement of social scientists through ELSI modes have been voiced in STS and cognate literature. As Williams (2006: 328) has argued, ELSI accounts too narrowly frame the scope of enquiry and are often based on a simplified linear model of innovation pathways and outcomes, which embeds an assumption that

> the societal and ethical implications of new S&T can be 'read off' [the technology] by the application of tools for ethical enquiry.

In other words, ELSI research makes use of a categorical distinction between "the science" and its "implications", enabling what Swierstra and Rip (2007) term a distinctive pattern of moral argumentation, where scientists do science and leave social, moral and ethical questions to experts – ethicists, theologians, lawyers and social scientists. This epistemological gap is enacted in ELSI practices as a division of labour, which reasserts the general assumption that having "read off" the implications of innovations, these

can be ameliorated by attending to safety precautions, risk management, and public opinion. These forces of discourse and practice contribute to positioning social scientists in such a way that our role has become characterised as the voice of risk and concern, and we are seen to be joyless and humourless, handwringers, truth-sayers and gate-keepers (Fortun, 2005).

Altogether, these critiques form the basis of an argument for building forms of social science scholarship and public engagement into the development of new technologies that overcome the limitations of ELSI. Current strategies and practices have responded to two key practical and conceptual issues: the timing of interventions; and the need to move away from the applications/outcomes focus. There are a number of approaches here, which represent a response to these problems, including, but not limited to:

i. Upstream public engagement (Wilsdon & Willis, 2004)

ii. Constructive Technology Assessment (Schot & Rip, 1997)

iii. Anticipatory Governance and Real Time Technology Assessment (Barben et al., 2008)

iv. Critical neuroscience as an exploration of coproductive knowledge production (Choudhury & Slaby, 2011)

v. Human Practices as an expressly "post-ELSI" approach (Rabinow & Bennett, 2012)

vi. Responsible Innovation (Owen et al., 2013)

The development of new research protocols and codes of conduct that mandate the inclusion of social science in technoscience research and innovation

practices, variously enacted through the above programmes, speaks to the implicit expectations of contemporary governance and funding regimes, and also to the efforts of social scientists to get involved in scientific practices in more productive ways.

Indeed, we were not compelled to respond positively to the requests that led to us becoming entangled in synthetic biology, but there were several reasons why we did (and continue to) choose to participate upstream in this emerging field. Such spaces provide us with funding and high levels of access to research sites and subjects. At an institutional level, they are often looked upon favourably because they show the "impact" of our social scientific research. Less instrumentally (and bearing in mind that the precise modes of our ongoing work differ in terms of their objectives, intimacy and forms), from our perspective, the hope for such projects is that "working with" scientists and getting further entangled could help to produce novel and more diverse forms of objects *and* knowledge for *all* participants. In this regard, we have – through becoming entangled in these initiatives for interdisciplinary research – sought to produce more collaborative relationships that move towards the co-production of problems, knowledge and innovations.

Given these developments in governance and STS scholarship and practice, we contend that we are already in a fuzzy space between ELSI and post-ELSI, where not only social scientists but also a limited number of policy makers and scientists have begun to talk about collaboration, even if this shift in talk is often accompanied by an understanding that such collaboration might then facilitate better outcomes as regards (negative) implications and the public acceptance of applications. Nonetheless, these entanglements have opened up novel collaborative opportunities that have yet to be reflected on at the level of their routine, everyday practice.

Taking Roles in Interdisciplinary Collaborations

In this section we reflect on a range of roles we have taken as social scientists in the area of synthetic biology whilst working towards post-ELSI collaborative practices. Some of these roles are ones we are keen to adopt and have worked hard to construct; some are roles that others, such as funders and scientists, assume that we play and use to justify our presence; and other roles have been imposed on us and demonstrate the continued legacy of ELSI logics and practices. We describe an array of practices involved in us actively taking-up, negotiating, or being more passively placed in particular roles. Our approach to roles is thus to understand how our attempts at collaboration with colleagues in the life sciences and engineering have been formed and deformed by various practices of making sense of what social scientists may or may not contribute to synthetic biology in the UK. Although our individual experiences have been different, both within our own history of attempts at collaboration and when we compared them with each other, we have found that it is possible to generalise some more abstract roles that we have taken more or less actively within these spaces. A number of elements have been involved in the consolidation of the roles that we describe below, including:

    i. scientists, engineers, research councils and other actors' use of ELSI and post-ELSI logics to make sense of and structure our role within technoscience projects;

ii. our own actions, (STS) dispositions and social networks, and how these are responded to by our collaborators; and

iii. the affective, political, symbolic and power dimensions of different contexts of working together.

Although we discuss the roles below as if they were discrete, we are keenly aware of the messy, convoluted and affective nature of our various entanglements with the synthetic biology enterprise, which at times have involved debts, obligations, concerns, loyalties, friendships, contradictions, hopes and fears. So whilst describing these more abstracted roles we also want to point to the schizophrenic negotiation of multiple roles that marks our experiences in synthetic biology. We realise that the messiness of our relations is not distinctive to this field. The anthropologist Diane Forsythe (1999: 22), for example, notes that often in fieldwork "the collapsed roles of participant, observer, critic, employee and colleague collide with one another." Similarly, in categorising the ideal-type roles of field research as "peripheral, active or complete," Adler and Adler (1987: 33–36) comment that "[t]here are times […] when they overlap, shift in character, or become dislodged." So there is an existing tradition of conceptualising the position of social scientists within sociotechnical fields by abstracting out from the mess of the day-to-day into more clearly defined roles. We want to re-visit these longstanding reflections on the roles of social scientists in the field and update them within the context of contemporary reorganisations of the natural and social sciences, focussing specifically on our attempts at collaboration and the construction of post-ELSI spaces in UK synthetic biology. We ask what work we are doing in these roles and how the roles are constructed from

within practices of politics, economics, governance, laboratory work, academic teaching, collegiate relations and so forth. Since we are all involved in different kinds of collaborations and with different groups of synthetic biologists, we cover below many diverse and sometimes contradictory roles, from the overtly instrumental through to the more explicitly antagonistic or to the position of being a critical friend, colleague and co-producer of knowledge.

"The representative of the public"

This role often serves as the initial position from which we are forced to negotiate more substantive relations with the synthetic biology world. In 2007, when one of us attended her first synthetic biology meeting, she was surprised to find her disciplinary affiliation listed as "Member of Society" on the programme. The Research Council organizers clearly assumed that as a social scientist she somehow represented society more than the scientists and engineers at the meeting.

Moreover, our colleagues in the sciences and engineering often approach us as experts in the views of publics, assuming that "public acceptance" and "risk perception" of their technologies and practices are the only crucial issues that need to be addressed. This is also how scientists and engineers often evaluate our potential contribution to grants during the review of funding applications. For example, two of us recently received external reviews of a grant application in which we had contributed a small social science research workpackage as part of the larger scientific grant. The only concern raised in the reviewers' comments about the grant as a whole was that "open discussions with the public […] must be implemented."

Such assumptions about public understanding then translate into

expectations of what our activities as social scientists should entail. We are often asked by synthetic biology practitioners to deliver "outreach" with the assumption that we can act as a kind of "social lubricant", greasing the wheels of synthetic biology and helping to generate "public acceptability" (Macnaghten et al., 2005). More sophisticated versions of this imagined role are that of "broker", "translator", "mediator" or "facilitator" between scientists and publics. These position us as delivering a service to the science and engineering community, rather than as contributing to collaboration through research activities. Such a role opens up possibilities for action as regards democratic dialogue, but constrains the potential of such action by ring-fencing where this kind of politics can happen as downstream or outside of day-to-day scientific practice. The adoption of ELSI logics by colleagues in the natural sciences and engineering contributes to positioning STS scholars as advisors on engagement, publics and impact, meaning that the possibility for transforming the practices of scientists themselves, or of developing new collaborative practices, is powerfully foreclosed.

"The foreteller"

In order to orient away from the role of representative of the public, we sometimes emphasise that we are interested in the upstream processes and governance of science and innovation. This insistence on being there from the beginning, however, can lead us to be cast in the role of "foreteller", and when combined with the use of extant ELSI logics this can lead to the expectation that our role is to forecast the way (as a linear, singular determination) in which a particular technology will or should develop, and how it will be apprehended by various publics.

STS researchers who promote the use of real-time technology assessment can find themselves cast in this role, which can become re-entangled with the "representative of the public" role when we are asked to predict which particular applications (or words used to describe an application) are likely to be more "acceptable" to "the public". In seeking to succeed in the funding game of science to service the "knowledge economy", "UKplc" and the "European Innovation Union", our colleagues' expectations of us are often shaped towards our capacity to help commercialise their products, which similarly forecloses a range of more collaborative relations.

In a recent round of funding applications one of us was asked to help shape which kinds of technologies should be selected as test cases for the acceptability of synthetic biology by various publics. The ELSI logics made use of in these discussions were sophisticated and indeed his scientific colleagues were open to the idea that different "interest groups" might have different concerns and the team would have to consult with experts in a range of contexts. However, the underlying determinism between technological design and its creation of particular social "outcomes" remained unchallenged. Rather than imagining such a consultation to be part of reconfiguring technological design practices, his colleagues envisioned social scientists in the grant alongside other "public experts" as helping to choose between different applications, essentially foretelling which would cause controversy and be unsuccessful and which stood a better chance of economic and public success.

"The wife"

Many of the roles that we inhabit during our attempts at collaboration have distinctive

affective and power relations, but the role of "wife" is perhaps most exemplary in this regard. Our collaborations often embed a gendered character, built upon the traditional divide between the masculine hard sciences as rational and empirical (Keller, 1982) and the feminine social sciences as emotional and intuitive. Here we identify three central facets of the wifely role: being *dutiful*, *gossiping,* and being a *trophy*.

In terms of the first element, of being dutiful, some of us find that we end up managing the emotional labour of a collaborative project in synthetic biology, by helping scientists and engineers communicate across disciplinary divides (with each other and with us) and by caring for the collaboration as it proceeds. For example, one of us (a female social scientist) was funded as an "administrator", not a co-Investigator, on a research grant, and made responsible for attending to the running of the interdisciplinary project, while substantive matters were overseen by a (male) scientist and a (male) engineer. This type of labour resembles that of wifely domestic work (Oakley, 1974). The gender component is important here, because in this wifely role we are often in a situation of having less power, resources and authority than those with whom we collaborate.

As others have noted, in situations of inequitable collaboration those with less power are required to be empathetic to those with greater power (Graeber, 2006). Moreover, in this inequitable relation we may take on roles in which we must manage our own feelings of resentment, disenfranchisement and subjugation through further emotional labour (Hochschild, 1975). For example, in one research project, one of us found that during an interdisciplinary academic workshop his frequently critical comments regarding the effervescence of synthetic

biologists about the positive future impact of synthetic biology on the world began to irritate one of the more senior co-Investigators on the grant. The co-Investigator began to openly display these emotions which served as a censure of the social scientist's role in the workshop. In order to repair the relationship and maintain working practices with the group as a whole the social scientist found that he had to – at least temporarily – affirm the sense that there was much to be hopeful about when envisaging a future for synthetic biology and manage his own feelings of resentment about this inequitable situation.

The second facet of the wifely role is that of the "gossipmonger", with collaborators perceiving us as being essentially interested in "who did what to whom" (one interpretation of our common research methods of observation and interview). It is not unusual for us to be approached at gatherings by synthetic biologists who start conversations with us by invoking a hushed tone of complicity and suggesting they have "gossip" to share. Importantly, the gossipmonger role can serve as a pressure valve for disagreements that erupt between interdisciplinary colleagues – we lend a patient ear and thus help to absorb feelings and diffuse resentments that might be inappropriate to share more publicly. As such, we are often implicitly made use of to manage the social dynamics and feelings of the group.

A third salient wifely role is that of the "trophy wife". This is another category that becomes imposed on us by (some) actors. For example, a (male) social scientist colleague described during one of our seminar series meetings how he was asked at an evening function by a (male) synthetic biologist how it felt to be the research centre's trophy wife. This was meant as a joke, and its resonances

would have been different if the social scientist had been female. However, the connotations of being compared to a trophy wife are clear, since trophy wives have a symbolic function to represent the husband's authority and success. In the synthetic biology configuration, the husband's role is that of entrepreneur, and it is perhaps no surprise that this dynamic has emerged in a field that has so tightly aligned itself with the aims and logics of capitalist innovation. A trophy wife is normally thought to have little merit beyond her physical attractiveness and is drawn to the marriage because of the wealth or the power of the man. She is a stereotyped figure that emerges out of patriarchal assumptions about what women should be. In a similar way, our subjugation in such configurations is based on the sense that we are just a symbol of ethical conduct in the synthetic biology research enterprise; and also perhaps that we are only there in order to get our hands on the scientists' research funds. Indeed, at times some of us have been publicly referred to as "parasites" or "parasynthetic biologists", a less gendered but nonetheless subjugated role. Whilst we find elements of the wifely roles to be undesirable, it is not to say that the more gendered dimensions of care, emotional conduct, ethical virtue and so forth are demeaning for us. Indeed, many of us have embraced these elements of the role and sought to demonstrate their value from within collaborations.

"The critic"

Sometimes we want to play the role of critic, and sometimes this is a role that others assume that we play. There are of course many different ways to be critical. For example, one can be a critic in the negative sense of judging something negatively or finding fault with it (as in "a critic of the government's policy"), or a critic in the

sense of judging the qualities or merits of a work (as in being a theatre critic). Forms of critique prevalent in STS include "unmasking" scientific developments by highlighting interests at play (such as gender and capital), and revealing power relationships (Hacking, 1999). Moreover, STS approaches can involve challenging expectations, hubris and hype and thus can appear to be sceptical about the potential of the technology to solve societal problems. This can lead to tensions and misunderstandings with our collaborators, because scientists and engineers, who might not see the social and political dimensions of their practices, can hear this type of critical engagement as seeking to undermine the validity of their work. They might then try to re-frame our critiques as downstream, external "issues", and denigrate them as "merely politics" or "personal opinion" and irrelevant to the actual work of making knowledge and technical objects.

A critical stance can be interpreted as suspicion, distrust or antagonism (Fortun, 2005), denunciation or even resentment (Rabinow & Bennett, 2012), and a critic can be seen as a joyless and humourless "naysayer". Indeed, as noted above, ELSIs are generally only thought of in terms of unintended *negative* downstream consequences. When ethical, social and economic consequences are seen to be *positive*, they are simply described as intended benefits, and form part of the promised future of the scientific endeavour. This narrative organisation of synthetic biology and other emerging fields of research and innovation (with the promises as an inherent part of the technology, and the perils externalized) is an important dimension of the ELSI framework, which shapes expectations about our roles in collaborations. We are seen to be the experts on – and the

voice of – the negative implications. We have commonly observed that natural science and engineering colleagues describe us being "here to make sure we behave ethically" or to "keep us honest." Although such statements might often be accompanied by a laugh or with wry intonation there is nonetheless a clear demarcation being made between who gets to do the work and who is there to observe it. This means that our scientific colleagues sometimes see us as being unhelpfully critical outsiders, as being unable to see the value and good of science and unwilling to celebrate their accomplishments.

When distrust or antagonism builds up from such a disjuncture, the position of critic can start to be seen as undercover agent, acting on behalf of untrustworthy external groups, especially if, as is the case for some of us, we are well connected with NGOs that campaign on synthetic biology. The use of our expertise to inform initiatives led by governments and research funders that aim to support the development of synthetic biology is usually seen by our colleagues as unproblematic (e.g. in the context of the BBSRC/EPSRC Public Dialogue on synthetic biology, or the UK Synthetic Biology Roadmap commissioned by the Department of Business, Industry and Skills), yet is perceived as betrayal when offered to non-governmental actors who are external critics.

"The trickster"
Some STS scholars are attracted to the role of trickster, jester or troublemaker. As Scott (2005: 49) describes, "The trickster is a practical joker, a witty and irreverent being who violates the most sacred of prohibitions." This is different from the "critic" because the point is to question, contradict and destabilize as a deliberate method of engagement by providing an alternative perspective and disturbing

engrained ways of thinking. This role is akin to the breaching experiments of earlier social scientists (Garfinkel, 1984), where the drive to disturb is a part of the sociological research process itself. The trickster often makes use of different devices to those common in social science, for example through use of parody and irony, performance and comedy. However, more recent developments in playful and creative methods (Back and Puwar, 2012; Mason, 2011) increasingly draw upon such devices. One vivid example of a trickster intervention occurred at a synthetic biology conference (SB6.0), where two STS PhD students presented a parodical poster that was intentionally blasphemous (Anonymous, 2015). In the synthetic biology community a particular comic book strip, published in *Nature* and produced by leading proponents of the field is often used in conference presentations to signal the fun and "adventure" that comes from working with bacteria in this way. The cartoon depict a young scientist learning how easy it is to work with bacteria when their "DNA parts" are black-boxed and can be obtained from a "catalog" and assembled to "encode your program" (Endy & Deese, 2005). The STS students hijacked this comic book by reworking the images to show a less sympathetic vision of synthetic biology practices and governance. Indeed, the scientists are vilified as cavalier, self-interested and ignorant. But the targets of their trouble-making intervention were not only the synthetic biologists at the conference but also the social scientists collaborating with them, who were pictured dupes, obscurantists and opportunists. The nature of the poster, taking on a parodic form, allowed the students to be frank about their feelings and concerns in a way that might not have been possible in a more traditional format.

However, the "trickster" role raises questions about the extent to which it can be combined with being "embedded" within research groups. Should one seek to criticise from outside or inside? At the same time, playing the role of trickster can be a useful mode through which to engage in debates around this very question since it troubles the distinction between insider and outsider. Trust (or the lack thereof) between colleagues can be made visible through such work, however it also places existing trust at risk and can lead to alienation. Moreover, in order to be productively destabilising it is necessary for those targeted to be open to critique and reflection and to be willing to engage with social scientists taking up the trickster role. Although the SB6.0 poster described above destabilised several of the STS researchers present (including some of the authors), the synthetic biologists at the conference largely ignored it, or walked by and said "cool!", oblivious to the intentions of the intervention (Aguiton, 2014: 453–454).

"The reflexivity inducer"

It has been argued by some social scientists and, to a much more limited extent, by some research funders and scientists, that we should become reflexive partners in scientific collaborations by exploring the normative assumptions that lie behind the choices that are made, or engaging in "opening up", as Stirling (2005) puts it. Such opening up may give rise to broader questions that go beyond the specific technology which is under scrutiny, such as questions about the aims of scientific research, resource allocation and priority setting, as well as what is meant by "good science" (Wilsdon et al., 2005). The aim of this type of role is to attempt to institutionalize reflexivity (Barben et al., 2008), in order to make scientists "more self-aware of their own

taken-for-granted expectations, visions, and imaginations of the ultimate ends of knowledge" (Macnaghten et al., 2005: 11). The institutionalisation of reflexivity could potentially enable both scientists and social scientists to imagine their work in ways that are not habitual and familiar.

Opening up is, arguably, best done by exposure to different perspectives, and some social scientists have maintained that seeking to make scientists more reflexive is too internal and not sufficiently encompassing of diverse viewpoints (Mercer, 2012). Exposure to different perspectives is a key aim of participative forms of technology assessment and some STS scholars take up roles in collaborative post-ELSI spaces through the explicit use of this form of expertise. In this role, scholars aim to help uncover social and political contingencies, and to contribute to shaping technological trajectories. However, as is the case for many of the other roles discussed, we often find that these kinds of relationships only gain credence among scientific colleagues and institutions when reframed within promises of "translation" and a contribution to public and/or market acceptance. Moreover, when recast in this way our work to open up science is sometimes reintegrated into the instrumental aim of ensuring a successful – commercial – outcome. As such, our attempts to challenge certain assumptions are legitimated, but other forms of more critical challenge (for example, on the patenting of objects or dominant models of health and medicine) are not taken up.

"The educator"

Most of us have been involved in the International Genetically Engineered Machine Competition (iGEM), in which teams of university students from around the world compete for prizes by creating novel microorganisms using standardised

synthetic biology parts (Frow & Calvert, 2013). Over the past six years, we have variously participated in iGEM as team members, team advisers and competition judges, helping teams to think about the "Human Practices" dimensions of their projects. In some cases we have moved towards more co-productive roles, and in others we have encountered potent forces that resist this reorganisation and retain a distinctly ELSI form.

The educator role differs from most of the other roles described because it is explicitly pedagogical, involving students who may not have yet embraced a particular disciplinary identity, are not yet so imbued with ELSI logics and practices, and are often open to new perspectives (such as those provided by STS). The disciplinary ambivalence that students can sometimes evidence affords opportunities for creative practices that embed reflexive, critical dimensions into scientific endeavours (Balmer & Bulpin, 2013). Both formal and informal pedagogical activities can be relatively comfortable ways of investing one's energy, owing to this possibility for creativity and also the authority that typically accompanies the "educator" role. But there is also a risk that we devote too much attention to engaging with students, at the expense of (often more frustrating) attempts to move more powerful actors towards increased reflexivity.

"The colleague"

In some ways, our research and teaching relationships with scientists and engineers are not notably different from those with our colleagues from the social sciences. We often attend the same seminars and conferences as the synthetic biologists, and find ourselves reading the same literature and asking similar academic questions. Furthermore, we meet not just in synthetic biology venues but also on university committees and exam boards, in corridors and coffee rooms, and even in our local parks. Some of us share supervision of students, teach on each other's courses, and go for dinner at each other's homes. As colleagues, we acknowledge each other as independent academics, although our joint activities are often more concerned with teaching students, achieving concrete tasks or simply having fun than developing a common research agenda or shared knowledge.

Sometimes we are even granted the status of "colleague" during our laboratory ethnographies, a circumstance where one might expect a different power dynamic to prevail. For example, one of us spent a year in a US synthetic biology lab, and was treated as an equal throughout – given desk space, and expected to contribute to lab meetings and discussions as any other member of the group. Working with research teams (either in an ethnographic capacity or as a co-investigator) means that we often work alongside students, post-docs, junior and senior academics, and changes within the team can affect the roles we play with different members of the group. We can be sad when group members leave, happy when a post-doc gets a permanent post, keep quiet when internal team tensions arise, or be supportive when inequalities are on display. The affective or emotional dimensions of different contexts are important in making different roles available and closing others off and so can powerfully shape our ability to move from role to role. Indeed, when we are colleagues it can sometimes be harder to navigate into other roles, for example in being a critic or trickster. On the other hand, developing a collegial relationship can produce trust and openness in ways that can then make it easier to co-imagine and practice "co-producer of knowledge" roles.

"The co-producer of knowledge"

In many ways the "co-producer of knowledge" role remains an aspiration in our collaborative relationships. In this role we imagine ourselves contributing directly to collaborative knowledge production through our own forms of expertise in STS, sociology, technology assessment, cultural studies and so forth. For example, when Rabinow and Bennett (2012) first started working at Synberc they were excited by the prospect of a co-production among disciplines and perspectives. Operationalising this goal, however, is often not straightforward, and that particular collaboration did not work out as originally hoped.

Nonetheless, some of us have had positive experiences in this area. For example, three of us have participated in a project exploring the use of synthetic biology in the context of water engineering. Our STS outlook ended up playing a role in shaping how the problems of water engineering were conceptualised. By exploring different ontological articulations of bacteria involved in engineering contexts, and by investigating what our colleagues understood to be a "barrier to innovation," we were better able as a group to envisage how synthetic biology solutions might need to be tailored to specific contexts of use. At the same time, this research contributed to STS analyses of the multiple ontologies of objects (Balmer & Molyneux-Hodgson, 2013) and performativity and innovation (Molyneux-Hodgson & Balmer, 2013). To give another example, in the Synthetic Aesthetics project in which two of us participated, a sense of genuine co-production of new knowledge at the intersection of disciplines emerged (Ginsberg, et al., 2014). Perhaps one reason for the lively and productive nature of this collaboration between artists, designers, synthetic biologists and social scientists was that no one group had epistemic authority over the direction of the research. Nor was there a sense that the social scientists had been "tacked on" to the project in an instrumental manner. Both of these projects have provided firm starting points for further and ongoing collaborations.

Moving between Roles: Playing the Chameleon

Our experiences of these roles differ widely over time, across projects and spaces, and between us as individuals. Some of us feel that we are under pressure to adopt the more instrumental roles described above (such as delivering public acceptance), and that roles of the "co-producer" variety have no apparent relevance for scientists, engineers and funders, and thus become impossible to negotiate. But even if it is for instrumental reasons that scientists initially forge collaborations with us, we have found that expectations can change over time and as we adopt alternate roles.

This brings us to one critical dimension of the contemporary post-ELSI experience, namely the practice of having to move back-and-forth between roles and "play the chameleon." In other words, various positions and actions become differentially possible across space, types of engagement and over time. It is far easier to experiment with co-production and induce reflexivity in the lab with a group of talented undergraduate students in an iGEM team than it is with a group of established professors of engineering and science during a meeting with cabinet MPs, civil servants and corporate executives. In this latter context the ELSI discourse becomes more potent. In this regard, when working with colleagues who are open to co-production it can nonetheless be extremely difficult to maintain such openness

when entering spaces where disciplinary authority becomes far more potent, for example as the political valence of the space changes. As some roles become more difficult to create, others become more difficult to resist.

The goals and aspirations of collaborators are often not mutually shared. STS scholars may have different interests and goals when entering collaboration than do colleagues in other fields, whether they are other social scientists, natural scientists, engineers or designers. Of course, having different goals can contribute to the success of a project as different members bring different expertise and outputs to interdisciplinary work. Disagreements about the purposes or goals of an activity, event, or project can be productive, but they can also create an obstacle to building trust between collaborators or damage the trust that has been built. This is not to say that goals have to be shared, but rather that the difference in goals connects to the affective dimension of collaborations, and that together these contribute to opening up or closing down possibilities for action and so to the (de)formation of collaborative relations.

In our experience, the initial organisational and strategic framing of a research project has proved particularly important in shaping the kinds of collaborative spaces which allow certain roles to flourish and multiply over time. For example, the egalitarian and open structure of the Synthetics Aesthetics project mentioned above created a space where it was possible to embrace the sometimes more difficult, risky dimensions of playing the trickster experienced in other projects. This is evidenced in the creative and diverse ways in which natural scientists, artists and social scientists worked collaboratively to play with the limits and visions of synthetic biology. For

example, Christina Agapakis (synthetic biologist) and Sissel Tolaas (scientist, linguist and artist) created "human cheese" by culturing microbes harvested from people's skin. The trickster role also enabled and in turn was nurtured by the adoption of other roles that were permitted within this space, namely those of reflexivity inducer and co-producer of knowledge.

Those of us who have been welcomed as colleagues on research projects and within scientific departments and laboratories have also found that the expectation of equality that can accompany the notion of being someone's colleague opened up spaces where we could more easily adopt roles as educators and reflexivity inducers. For example, by being invited to participate in weekly lab meetings, we have found places to introduce synthetic biologists to some ideas from STS and to use these concepts to encourage them to think about what they did day-to-day. These roles have often quietly opened doors for us to take up other interesting and productive positions within these collaborative interactions.

Conversely, the type of role we are expected to play can be rigidly proscribed from the outset, leaving little room to develop the more collaborative, co-productive kinds of roles we seek to inhabit. In particular, the organisational classification of our role can be very restrictive and can set up notably different power relations such as in one author's experience of only ever being invited to participate in one particular research group when there was a public engagement event being organised. The group in question had not collaborated with a social scientist before but had funding for synthetic biology research that required them to do some public engagement events. This meant that every now and again over a few years the social scientist

was asked to fill roles that were attuned to these more public spaces. Barriers to developing a more substantive relationship involved differences in institutional affiliation, a lack of funding to support such work, and – being on a temporary contract – unknowns regarding the future of the relationship. At the same time, he was engaged with colleagues elsewhere to develop a funding application that would involve more collaborative entanglement. When the application was successful the attempts to move from public engagement facilitator to co-producer of knowledge with the previous group fizzled out as his time became more constrained, the enthusiasm waned, and his responsibility to the new project took precedence.

Other examples of "playing the chameleon" can take place over a very short period of time. In one meeting, one of the authors of this paper experienced being positioned as a trophy wife with a tick-box role in representing the social and ethical dimensions of synthetic biology, a representative of the public, and a foreteller of public attitudes towards synthetic biology all in one meeting! Further, in pointing to some of the limitations and assumptions being made in the discussion she found her roles proliferating into trickster and critic and occasionally morphing into positions where more co-productive and reflexive work could be done. Moving between roles within a given situation can thus be something that social scientists strategically use to find a position from which to voice substantive critique. Trying out different roles, or adopting one (trophy wife) in order to move into another (representative of the public) and then another (critic) is a common feature of negotiation through the current uncertainties in status that social scientists have within attempts at post-ELSI collaboration.

Others among us have experienced similar transitions between critic, public representative and co-producer of knowledge and have found these different roles to be generative of sometimes surprising power dynamics. For example, one author found that he could be quite easily dismissed when he inhabited a critical role as his scientific collaborators could ignore him as merely a naysayer who was trying to burst the bubble of synthetic biology promises. Contrarily, he found that "representing the public" was sometimes quite a powerful position because scientists and engineers, through their imaginaries of the public and the future, tended to invest the public with the power to derail a whole programme of research. In this regard, the role was actually sometimes a useful way to have legitimate concerns about sociotechnical practices heard in a context that was otherwise quite closed to friendly criticism. Of course, that role also became a little difficult to then divest since it had been adopted quite forcefully. So moving from role to role and playing the chameleon invokes shifting power relations, and indeed can be one response used by social scientists to a given set of power relations as they are encountered in a specific space. But of course adopting roles that can be more useful or comfortable within inequitable power relations does not necessarily help to create ruptures and resistance to those power relations and may – in the longer term – have the effect of further consolidating inequities.

Lastly, although being a co-producer of knowledge is often what we aspire to do in our collaborations, this role can itself become problematic when we find ourselves contributing to an element of the project that we remain uncomfortable with. This raises questions as to what extent we can withdraw or distance ourselves from positions that we have ended up in,

particularly when we have fought for them, but also when we have inhabited them less intentionally. Moreover, synthetic biologists appear to be under less pressure to negotiate their way through various roles in order to maintain the collaboration. Certainly, they must adopt different roles as they move through power relations in governance, industry, laboratory and university hierarchies and so forth. However, these have more to do with the everyday nature of scientific practice than they do with the development of post-ELSI collaborations. In this regard, STS scholars, as well as other social scientists, are generally the ones who take or are forced to adopt the role of "chameleon" in order to maintain relationships. Synthetic biologists less visibly, so far at least, adopt this chameleonic role in order to support experiments in collaboration. Power relations in the post-ELSI space thus place different weight on participants to ensure their continuation or open them up to change. So whilst there are opportunities that emerge from skilfully negotiating from role to role, the option to divest oneself of this requirement comes with a high price, in terms of one's career, academic standing, wasted time, emotional labour and so forth.

This analysis suggests that post-ELSI scholarship has to take into account various elements involved in adopting roles within collaborations, including power dynamics and affective and emotional relations. We should more thoughtfully attend to how these elements affect the roles that individuals can or have to play in interdisciplinary technoscience and with what implications for knowledge production and innovation practices.

We think that there are some lessons to be learned from our experience. However, there cannot be hard and fast rules given that the contexts vary so powerfully, the roles one adopts may shift frequently, and because what is at stake is the creation of relationships of trust and understanding, even – perhaps especially – in the face of unshared goals and inequitable power relationships. Therefore, rather than offering a list of rules for those seeking to move towards post-ELSI spaces, we now briefly propose four orientations to post-ELSI collaborative practices that we believe can be productive when talking about and practicing collaborative relationships involving STS, natural science and engineering.

Orientations for Post-ELSI Collaboration

Collective Experimentation: As post-ELSI spaces develop we have to experiment more with forms of interaction through which social scientists, natural scientists, engineers and other actors might work together. We have to find ways in which our forms of expertise can be part of mutually productive collaborative relationships. This means we need to do experiments collectively and also to experiment in making collectives. Much like experiment in science, we must be adventurous and playful, willing to explore the unknown, tinker with our practices and be resilient in the face of failure.

Practising Collaborative Reflexivity: As post-ELSI spaces emerge there are perhaps renewed opportunities for experimentation with forms of reflexivity. STS researchers have discussed reflexivity in myriad ways since the field's inception, although there has been more talk than practice. Since existing structures of political power and governance of science both constrain and enable different possibilities for collective experimentation, we must be reflexively attuned to how our collaborations are

enacted in day-to-day practice and how they are awarded credibility or not. Reflexivity itself should be collaborative; it should involve scientists and engineers together with STS researchers (and others) in its practice. This can help to free the STS researcher from a position of moral judge and naysayer and implicates everyone in working towards improved relations.

Taking Risks: Some positions involve more risks than others. Ongoing collaborative relationships require that we move from role to role, sometimes shifting into more critical or antagonistic positions, other times into more coproductive and collegial alignments. The various roles one can take involve different levels of risk and different kinds of vulnerability. Nonetheless, we believe it is vital that we take risks and experiment with form-giving and reflexive collaboration in order to produce novel post-ELSI entanglements. However, experiments often fail. We have to be comfortable with failure, but also acknowledge that failures will have different affective dimensions and impact differently on careers depending on seniority, gender, discipline and so forth. Opening-up these differences to discussion might help to ensure that we are better prepared for the failure of our collaborative experiments.

Opening Up Discussions of Unshared Goals: We have to negotiate expectations around what we hope to achieve from these collaborations and how this might differ for our engineering and science colleagues. This can often mean very frank discussions that – although they do not produce shared goals – can produce shared interests and more mutual understanding. We might not have to have shared goals but we might still have to be honest about this. Speaking honestly with each other and

seeking to negotiate mutual understanding without demanding mutual goals can be difficult and so place the collaboration at risk of failure. Some argue that the answer lies in being comfortable with a degree of concealment (Fitzgerald et al., 2014). However, when working in long-standing collaborations and moving from role to role different positions may make concealed goals and dispositions difficult to maintain. So although frank discussion can itself be risky it is perhaps worth this risk if we are to move towards more interesting and productive relationships in the longer term.

Conclusion

Ethics, under the banner of ELSI, has been predominantly considered as a downstream, object-oriented enterprise concerned with "reading off" the ethical from the technical. We have described how ELSI logics act as a force in the shaping of scientists' invitations to us to collaborate and how they are used to position social science in relation to the research and innovation endeavour. Indeed, they are so deeply embedded in scientists' and funders' understandings of "the social" that they often become the most significant force against which our work to negotiate a deeper collaboration must be orientated. Like many other STS scholars, we have endured frustrations when struggling to negotiate acceptance of our expertise when it is unwittingly repositioned by our colleagues or actively resisted. This requires us constantly to reflect on the distance we are prepared to go in negotiating research relations and working towards collaborations in more intransigent spaces, and points to the difficulties experienced when colleagues are reluctant to try alternative forms of collaborative practice.

Set against the background of ELSI, its critique and the emergence of post-ELSI collaborative relationships, we have discussed a range of different roles and some of the elements involved in making these roles more or less comfortable, and more or less difficult to adopt. The collation of our individual experiences in working towards collaborations into these descriptions represents one of the primary contributions of this paper. Moreover, we have opened-up considerations of power and the affective and political dimensions of collaboration, some of which become particularly acute when considering the contemporary requirement for social scientists to move from position to position and role to role to help keep collaborations working. As such, we have provided a novel argument regarding the contemporary movement towards interdisciplinary collaborations between natural and social scientists, one that highlights how social scientists are expected to "play the chameleon" within changing networks of power, affect and politics.

Although we have argued that our relationships with colleagues in the natural and engineering sciences must often be developed from within or in dialogue with the stubbornly resilient framework of ELSI, it is also possible to move towards post-ELSI practices that offer far more in terms of their collaborative promise. Finally, we have briefly outlined some orientations that might prove fruitful for others seeking to negotiate different kinds of relationships and we believe that there is much hope for the creation of productive collaborative forms.

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