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INTRODUCTION

Inter- and Transdisciplinary Interfaces in Synthetic Biology

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Introduction to the Special Section

For almost two decades now, "synthetic biology" has been used to label realms of cellular, molecular and chemical biology that focus on designing and constructing organisms for human use. In a narrow sense – in which synthetic biology is aimed at the de novo design and construction of artificial life forms – its distinct fields are commonly identified as engineering biology, chemical synthetic biology and protocell biology [1, 5].[1] In a broader sense, synthetic biology is sometimes thought to consist of "research tribes" [1] that share some common features and interests. Besides the aim of designing and constructing organisms or their components (in this broad sense not necessarily from scratch), characteristic features include: the adaptation for biological purposes of engineering concepts such as modularisation and standardisation, the reliance on increased IT computational power and increasingly cheap and effective genomics tools, and the use of insight from systems biology.

Envisaged applications of synthetic biology range from biofuels, disease control and environmental protection to military and space applications [3, 15, 19]. Synthetic microorganisms – for high value food products as well as energy – are likely to become crucial elements of the 21st century's "bioeconomies" [18].[2] However, bioeconomic political agendas entail considerable potential for conflict, for example over biomass (e.g. [7, 13]). Research topics in the evaluation of synthetic biology have therefore included socio-economic issues alongside biosecurity concerns about the ease of producing (some) synthetic biology products, biosafety aspects related to potential release into the environment and traceability, as well as ethical issues pertaining to the philosophical implications of engineering organisms. The field has thus attracted considerable attention by NGOs, in scientific policy advice and technology assessment (TA) – where it is seen as a typical example of new and emerging technologies (NEST) – and in the associated social sciences and humanities. Numerous

[1] Protocell biology is sometimes excluded, most prominently in the recent European Commission opinion [8], to allow a better fit of synthetic biology products with existing regulation of genetically modified organisms.

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[2] A concise definition of "bioeconomy" is available on the homepage of the German Bioeconomy Council: http://biooekonomierat.de/home-en/bioeconomy.html. Accessed 15 August 2016

reports have provided analyses of the risks and opportunities as well as of the wider ethical and societal aspects of synthetic biology (e.g. recently [4, 6, 9, 10, 19]).

There is wide agreement about the usefulness of early assessments of NEST, as reflected in the European Commission policies of "Science with and for Society" and "Responsible Research and Innovation": although there may be insufficient knowledge about realistic scenarios to conduct risk assessments, early evaluative activities are thought to help create awareness among decision makers and may also help trigger public dialogue about synthetic biology and its potential applications (e.g. [11, 20]). Interdisciplinary and transdisciplinary collaboration are important features of the early assessment of NEST. But while the need for interdisciplinary discourse is acknowledged, its inherent difficulties are also a well-known challenge. International as well as national funding bodies have recognised this situation, and the German Federal Ministry of Education and Research (BMBF) has funded a range of long-term interdisciplinary projects, as well as shorter activities such as summer schools, in its Ethical, Legal and Social Aspects (ELSA) programme.

One central aim of ELSA summer schools has been to introduce young scholars to interdisciplinary discourse. Participants at the summer school (upon which this special section is based) constituted a highly heterogeneous group with representatives from (synthetic) biology, social sciences and the humanities. [3] Individual contributions from the participants were revised on the basis of their experiences during the summer school and brought together in an edited book [12]. Two of the contributions to this special section were also authored by individual participants. The other two contributions result from collaborations that arose from the summer school. All four papers address communicative interfaces between the synthetic biology community and broader publics.

In the first paper, Clemens Blümel uses Michael Callon's "Sociology of Translation" framework to discuss two types of persuasion that he considers to be of particular importance in descriptions of the engineering branch of synthetic biology. One of the persuasion practices is to propose visionary models – a practice that is well known in NEST. The other practice, of constructing building tools as heuristic models (e.g. the toggle switch), is more specific to synthetic biology. In this regard, textual constructions of future relevance differ from other disciplinary accounts such as nanotechnology. Using qualitative content analysis of excerpts from seminal synthetic biology review papers, Blümel shows shifts in the rhetorical patterns of addressing the audience: problems are constructed to relate to specific scientific or extra-scientific audiences. For the scientific audience, transformation of biological artefacts into functionalised objects becomes a driver of enrolment into the disciplinary identity of synthetic biology. In addition, visions of synthetic biology become persuasive with respect to societal relevance through the integration of artificial objects that provide proofs of principle.

The second paper in this section addresses two-way communication in a direct meeting between young representatives of synthetic biology and political youth party representatives in the Netherlands. Virgil Rerimassie provides us with a detailed account of the "Meeting of Young Minds" organised by the Dutch Rathenau Instituut in 2011. Capitalising on the European-African "jamboree" of the International Genetically Engineered Machine (iGEM) Competition that took place in Amsterdam, iGEM team members were brought together with young politicians for a public panel debate about synthetic biology. Rerimassie describes this TA exercise as contributing to a broader set of "activities to bring synthetic biology into societal and political debate", and also as providing "empirical data on the possible viewpoints of Dutch political parties on synthetic biology". The organisers thus learned about the potential of such meetings as participatory tools, and obtained a basis for anticipating where political challenges for synthetic biology may arise. Rerimassie concludes that the meeting did indeed succeed in broadening the debate on synthetic biology. And while it supported mutual learning and understanding among the participants, it also provided some indication of potential areas of political tension: (1) the evaluation of potential benefits of synthetic biology for addressing, for example, "grand challenges"; (2) the risks involved in the deliberate release into the environment of synthetic biology products; (3) the moral boundaries of human intervention in living organisms; and (4) the extent and mechanisms of political control of synthetic biology.

In the third contribution, Rerimassie joins philosopher Mirko Ancillotti, political scientist Walburg Steurer

[3] See www.ta-synbio-summerschool.de. Accessed 15 August 2016

and TA colleague Stefanie B. Seitz in an interdisciplinary analysis of trends in the synthetic biology science-society interface: will synthetic biology bring about new and less controversial genetically modified organisms, or will it lead to more conflicts (cf. [14, 21])? The authors draw on results from the Meeting of Young Minds described above, on citizen panels and focus group studies, as well as on the media portrayal of synthetic biology. They find that a low salience of synthetic biology prevails in the public, although lay people often know more about synthetic biology contents than they associate with the term. The positions expressed during the Austrian citizen panels conducted by Steurer parallel some of the issues identified during the Meeting of Young Minds; especially regarding the political and regulatory control of synthetic biology, and the demand for information and transparency. Another finding is that citizen panel participants express sceptical or ambivalent fundamental attitudes towards synthetic biology, and resignation in light of the ineluctability of scientific and technological progress. By contrast, the tone is generally positive in media coverage of synthetic biology. Media analyses demonstrate that scientists have a strong influence on science journalism.[4]

The fourth paper in this section is written by synthetic biologists Cyprien Verseux, Carlos G. Acevedo-Rocha, Fabio Chizzolini and Lynn J. Rothschild.[5] They reflect on their perceptions of the other summer school participants' conceptions of synthetic biology. They contend that the "non-biologist attendees" lacked "a clear vision of what is actually happening on today's benches", and that this made them prone to mistakenly equate media-relayed and distorted utopias with real-world synthetic biology. Although they appreciate the aims behind efforts to anticipate potentially problematic applications, Verseux et al. think that failure to understand the nature of synthetic biology causes irrelevant fears and unrealistic expectations, which in turn obstruct constructive debates about real-world synthetic biology and its opportunities. According to Verseux et al., direct communication and better knowledge transfer might broaden the synthetic biologists' horizons and help non-biologists engage with real-world synthetic biology in a more relevant way.

Concluding Remarks

When ethicists and social scientists become involved in interdisciplinary biotechnology projects, the collaboration can serve to genuinely increase mutual understanding. Disagreements caused by superficial misunderstandings, lack of information, and even different perspectives, can be resolved. However, knowledge transfer alone is not known for turning the tide in relation with the public (c.f. [2]) – and probably not in interdisciplinary relations, either. Disagreements can be deeply rooted in the socialisation within disciplines, in epistemological traditions, in interests, or in ethical and political positions. This sometimes gives rise to suspicions that bench-side evaluators may use their insider knowledge to inform negative communication about biotechnology and erode the trust of other actors. And instrumentalisation may also work the other way round, when representatives of evaluative disciplines serve communication and legitimisation purposes. Mysjka and Heggem have paraphrased negative roles that may therefore be attributed to evaluators as "Trojan horses" vs. "useful idiots" [17].

Our summer school made possible a week's direct contact and practice in interdisciplinary understanding; as far as we recall, however, the "misconceptions of synthetic biology" theme discussed by Verseux et al. for this special section was not a recurring topic at the time. The atmosphere was constructive and respectful – was it even too friendly to promote discussion? As one participant, Inna Kouper, put it in the evaluation round: "We're being too nice to each other; we're trying hard to downplay our disagreements." We take this observation as an inspiration to look more closely at the roles of different actors in practising interdisciplinarity. An ELSA project that invites natural scientists to join a group of evaluators (rather than inviting representatives of social sciences and humanities into the lab) is a corollary to ethics and social sciences at the bench-side. There can be a transfer of knowledge, and representatives of science and technology may enter the philosophical and evaluative debate (e.g. [5]). But may scientists also enter the evaluative fora "in Trojan horses"? And, on the other hand, may they be instrumentalised as sources of legitimisation for evaluations?

[4] In synthetic biology, although strategies of media presence have been marked by inconsistencies and disagreements within the field, guidelines for science communication have already been established [16].

[5] Lynn J. Rothschild was not present at the summer school, but was a supervisor to Cyprien Verseux at the time.

Achieving a good level of interdisciplinary debate in the societal evaluation of NEST is by no means a trivial task. Knowledge is an important condition – though not sufficient on its own – for open and constructive dialogue, which is in turn considered to be a promising way of arriving at NEST policies that may prove acceptable for society at large [20]. Long-term interdisciplinary groups typically move on to sorting out the reasons for disagreement at increasingly deep levels of evidence, socialisation, epistemology and interests. It requires considerable willingness, competence and time to transcend such boundaries. Sometimes this process leads to new levels of mutual understanding, although even long-term projects regularly fail in this regard. Short-term interdisciplinary exercises like summer schools can offer glimpses of such processes, inspire individuals, and bring foci for further activities to the fore.

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References

1. Acevedo-Rocha CG (2016) The synthetic nature of biology. In: Hagen K, Engelhard M, Toepfer G (eds) Ambivalences of creating life. Societal and philosophical dimensions of synthetic biology. Springer, Heidelberg, pp 9–53
2. Bauer MW, Allum N, Miller S (2007) What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. Public Underst Sci 16:79–95
3. Benner S, Sismour M (2005) Synthetic biology. Nat Rev Genet 6:533–43. doi:10.1038/nrg1637
4. Boldt J (2016) Synthetic biology: metaphors, worldviews, ethics, and laws. Springer VS, Wiesbaden
5. Bölker M, Engelhard M, Budisa N (2016) Synthetic biology: Diverse layers of Live. In: Engelhard M (ed) Synthetic biology analysed. Tools for discussion and evaluation. Springer International Publishing Switzerland, pp 27–50
6. Engelhard M (ed) (2016) Synthetic biology analysed. Tools for discussion and evaluation. Springer International Publishing Switzerland
7. ETC Group (2010) The New Biomassters. Synthetic Biology and the Next Assault on Biodiversity and Livelihoods. Communiqué nr 104. http://www.etcgroup.org/sites/www.etcgroup.org/files/biomassters_27feb2011.pdf. Accessed 15 Aug 2016
8. European Commission (2014) Opinion on Synthetic Biology I: Definition. http://ec.europa.eu/health/scientific_committees/consultations/public_consultations/scenihr_consultation_21_en.htm. Accessed 15 Aug 2016
9. European Commission (2015) Opinion on Synthetic Biology II: Risk assessment methodologies and safety aspects. http://ec.europa.eu/health/scientific_committees/consultations/public_consultations/scenihr_consultation_26_en.htm. Accessed 15 Aug 2016
10. Giese B, Pade C, Wigger H, von Gleich A (2015) Synthetic biology. Character and impact. Springer, Heidelberg
11. Grunwald A (2011) Responsible innovation: bringing together technology assessment, applied ethics, and STS research. Enterp Work Innov Stud 7:9–31
12. Hagen K, Engelhard M, Toepfer G (2016) Ambivalences of creating life. Societal and philosophical dimensions of synthetic biology. Springer International Publishing, Heidelberg and Berlin
13. Hildebrandt J, Budzinski M, Siebert A, Bezama A, Thrän D (2015) Further developments of Life Cycle Sustainability Assessment (LCSA) frameworks in the context of bioeconomy. Zehn Jahre transdisziplinäre Nachhaltigkeitsforschung an der Universität Leipzig : Festschrift anlässlich des zehnjährigen Bestehens des Instituts für Infrastruktur und Ressourcenmanagement (IIRM). Studien zu Infrastruktur und Ressourcenmanagement 5. Logos-Verlag, Berlin, pp 125–130
14. Kaiser M (2012) Commentary: looking for conflict and finding none? Public Underst Sci 21:188–194
15. König H, Frank D, Heil R, Coenen C (2013) Synthetic genomics and synthetic biology applications between hopes and concerns. Curr Genom 14:11–24. doi:10.2174/1389202911314010003
16. Mazerik J, Rejeski D (2014) A Guide for Communicating Synthetic Biology. Wilson Center, Washington, DC. https://www.wilsoncenter.org/publication/guide-for-communicating-synthetic-biology. Acessed 15 Aug 2016
17. Myskja B, Heggem R (2006) The human and social sciences in interdisciplinary biotechnology research: Trojan horses or useful idiots? In: Kaiser M, Lien M (eds) Ethics and the Politics of Food: Preprints of the 6th Congress of EurSafe. Wageningen Academic Pub, pp 138–142
18. Organisation for Economic Cooperation and Development (OECD) (2009) The bioeconomy to 2030—designing a policy agenda. OECD, Paris. http://www.oecd.org/futures/bioeconomy/2030. Accessed 15 Aug 2016
19. Sauter A, Albrecht S, van Doren D, König H, Reiß T, Trojok R (2016) Synthetische Biologie – Die nächste Stufe der Bio- und Gentechnologie. Arbeitsbericht Nr. 164. Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag (TAB), Berlin
20. Seitz SB (2016) Let's talk about… synthetic biology – emerging technologies and the public. In: Hagen K, Engelhard M, Toepfer G (eds) Ambivalences of creating life. Societal and philosophical dimensions of synthetic biology. Springer International Publishing, Heidelberg and Berlin, pp 157–156
21. Torgersen H, Hampel J (2012) Calling controversy: assessing synthetic biology's conflict potential. Public Underst Sci 21:134–148. doi:10.1177/0963662510389266