CDT in BioDesign Engineering: Reflections on individual RRI advisory sessions (2nd cohort)

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Background. As part of the EPSRC Centre for Doctoral Training (CDT) in BioDesign Engineering, individual advisory sessions on responsible research and innovation (RRI) were run for students in the second (2020-21 intake) CDT cohort. Participants comprised ten Master of Research (MRes) students based at Imperial College London (ICL) and two PhD students associated with the Future Biomanufacturing Research Hub (Future BRH) at the University of Manchester. The advisory sessions were led by the CDT's RRI team (from University of Manchester and University College London), working in pairs. The sessions ran as pre-booked 45-minute slots hosted across two days (29th June and 2nd July 2021) via Zoom due to continued COVID-19 restrictions. The aim of these sessions was to discuss the operationalisation of RRI in the context of each student's specific research project, the broader role of RRI in their professional development, and to respond to any questions they might have. As preparation, students were asked to review a journal paper and a video addressing RRI (see Resources). These resources provide an accessible overview of RRI and its relevance to both scientific research and early career researchers. Students were also asked to share the latest copy of their draft PhD research proposal with the RRI team.

Individual RRI Sessions. During their session, each student was encouraged to discuss their understanding of RRI and their research within this context. The RRI team asked students questions on broader RRI themes, the student's understanding of RRI, and the EPSRC's AREA Framework for Responsible Innovation (anticipation, reflection, engagement, and action). Discussion was tailored to each student's research topic and individual needs. Further steps for engagement and RRI progression were discussed. Following the individual meetings, students were asked to write a short reflection on their plans to incorporate RRI into their research project and professional development. These reflections were read by the RRI team, who then provided individual feedback on this work to the students.

The approach used for these sessions built on the experience of similar advisory meetings in 2020 for the first cohort of CDT students. For the 2021 sessions, the RRI team aimed to keep the discussion open rather than adhering to a fixed protocol. We also placed more emphasis on the RRI themes of anticipation and reflection, although engagement and action options were discussed. We provided opportunities for student questions.

Student Reflections. CDT students generally demonstrated motivation and capability to reflect on their work from ethical, environmental, and societal perspectives, both in the long- and short-term, including consideration of issues around intellectual property, data and open access, risk, sustainability, distribution of benefits, funding, and gender representation. Here are a few examples of the reflections by participating students on RRI and the value of their participation in the RRI programme component:

❑ *What does RRI mean to you?* "Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present. The four dimensions of responsible innovation include: anticipation, reflexivity, inclusion, and responsiveness."

❑ *Reflecting on terminology.* "Another general consideration that I believe is important in ethical research is to be careful of how new terms will be received by the public. When promoting one's field of work it is popular to create metaphors and catchy new terms to grasp people's attention. For example, within this project the term 'genome scrambling' would probably be met with fear and misconception. Within scientific circles this may be a 'safe space' to do this, but when these phrases spread to the media and members of the public, they often lose their context and can be damaging to the reputation of the field or to society."

❑ *Consideration of possible unforeseen or unwanted impacts:* "It is crucial to anticipate the potential failure points of the research, whether that be that the technology functions or spreads in an unexpected manner or if other emergent effects on the environment may occur"

RRI Team Cross-Cutting Feedback. In addition to individualised comments, the RRI team provided cross-cutting feedback based on common themes that had emerged in the advising sessions and student written reflections. Key points communicated to the students included:

❑ Students were asked to consider what RRI meant to them, and the value it could contribute not only to their research but also to their personal and professional development.

❑ RRI should not be viewed as a 'tick box' exercise: issues identified through anticipation and reflection stages need active responses to put these insights into action. Each research project has the potential to create a range of impacts. While power to influence some aspects may be many steps removed, in anticipation and reflection

stages there is a need to identify which impacts projects could be responsible for, leading to defining and implementing actions that should be undertaken in response, or at least in preparing for a response.

❑ Much of RRI is about engaging with uncertainties, many of which are complex and multi-faceted with a range of different stakeholders. What may be beneficial socially, for example, may have negative impacts economically. The students were asked to consider the questions they need to be asking themselves for the consideration of their scientific research in a real-world context, including challenging questions of ownership, responsibility, regulation, or equity.

❑ Active engagement with a wide range of stakeholders is vital, and a strategy for engagement needs to be considered and implemented as students' advance their research. It is important that engagement activities allow clear communication and opportunities for interaction and learning without prejudice or prior assumptions. The RRI team have offered guidance on how to implement engagement activities.

RRI Team Reflections. Student participation and engagement with the individual RRI sessions generated useful discussion: students demonstrated an understanding and appreciation of core RRI themes and how these might be applied to their research. Students were able to reflect on their work from ethical, environmental, societal and economic perspectives, and present potential future possibilities for their research within these themes. The informal nature of the session also allowed students to talk freely about their MSc/PhD experiences, such as PI interaction, group dynamics, gender representation, the effects of the pandemic, mental health, and other concerns.

As experienced last year, students mostly described their exposure and engagement with RRI as occurring solely through their participation in the RRI component of the CDT programme, with little to no RRI engagement within their department or with their supervisors. This is likely to have been exacerbated by a lack of in-person contact as a result of the pandemic. The relationship of the student with their supervisor, as well as the level of interaction of the PI with RRI, was identified as an important precursor to the importance afforded to this aspect. The RRI team encouraged students to explicitly discuss RRI aspects with their supervisor(s). In one case, the RRI team has met the student and supervisor together to mutually discus RRI aspects, and this is a practice that can be further expanded.

A need was highlighted for more literature that bridges the gap between RRI and science, with RRI considerations of scientific research included within the methodologies, and RRI papers that provide case study examples of how RRI can be applied in 'the real world' of research. Students working on projects either sponsored by a company or where collaboration with industry is significant are presented with additional challenges toward engaging and using RRI, particularly in raising issues of responsibility and engaging in discussions around intellectual property, sustainability and alternative research pathways.

Some students had initial difficulties in applying RRI to their specific research projects, due primarily to the early-stage nature of these projects, but also to the project's specificity and orientation. However, in these instances, students were still able to impressively engage RRI when asked about the wider implications of engineering biology and the related ethical and policy debates. The RRI team recognise that it is important to encourage students to consider the relevance of RRI to both their specific projects and engineering biology more generally. Additionally, the convergence of engineering biology and greater computational capability is an area that warrants additional attention by the RRI team, particularly when it comes to student projects that are either using significant computational methods for prediction and analysis or developing software to facilitate applications. In this way, students working on the development of processes or techniques can develop ways of thinking about RRI even when specific applications cannot yet be identified.

Resources. Students were asked to review the following items prior to the advising session: J Stilgoe, R Owen, & P Macnaghten, Developing a framework for responsible innovation, https://doi.org/10.1016/j.respol.2013.05.008; and Responsible Research and Innovation – a video where Claire Grierson, Professor of Biological Sciences at the University of Bristol, presents her perspectives on RRI. In follow-up, students were reminded of, and provided with, BSI PAS 440 on Responsible Innovation (see: https://www.dropbox.com/s/bjld1drocvs8ebh/PAS440_pdf.pdf?dl=0)