The DNA of socially responsible innovation

Social and natural scientists need to establish mutual understanding and a common language to efficiently work together

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The nature and purpose of academic and industrial research has slowly been changing during the past decades. Academic research, in particular of the applied nature, is more frequently done in collaboration with industrial partners and attracts funding from industry or private foundations that support research. Even public funding agencies increasingly require scientists to justify their work by explicitly asking them to clarify potential social relevance. Industrial research and development (R&D) not only needs to come up with sophisticated and competitive new products and services but also has to demonstrate social or environmental responsibility to contribute to a more positive corporate image [1]. As a general trend, scientists, both in academic and industrial research are increasingly expected to adopt so-called Socially Responsible Innovation (SRI) practices.

To install SRI, policy makers and scholars from the social sciences and humanities encourage natural scientists and engineers to actively integrate social and ethical considerations into their R&D [2–4]. These considerations concern environmental sustainability, public health and safety, legislation, communication, research integrity and so on. Most of these issues are more relevant in development and translational research, where scientific discoveries are closer to actual applications and new products. As such, SRI is especially important for industrial R&D and academic applied research (but possibly less so in fundamental

scientific work such as theoretical physics). These considerations of relevant social and ethical aspects are best realised through close collaboration between natural and social scientists, in which natural scientists and engineers provide their expertise on the particular project, and social scientists provide expertise on the social and ethical aspects and how to include these in R&D practice.

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Such collaborative research projects have been carried out worldwide during the past decades. One of the most prominent ones was initiated by Erik Fisher at Arizona State University in the USA: the Socio-technical Integration Research (STIR) is a “coordinated set of 20 laboratory engagement studies to assess and compare the varying pressures on—and capacities for—laboratories to integrate broader societal considerations into their work” [5]. These and similar studies have found that collaborations between natural and social scientists could generate more and better research options and set research goals and priorities by enriching research

projects with social and ethical dimensions that would otherwise have been overlooked [6,7]. Currently, however, experience is limited, since collaborations are difficult to set up. Natural and social scientists speak different languages, and as such find it difficult to understand one another [8]. Social scientists need a practical context to fully understand how SRI can positively contribute to R&D practice, while natural scientists require tools to answer policy calls for SRI.

The collaborative studies mentioned above have mostly focussed on R&D practice in various ‘application-inspired’ research environments, such as nanotechnology or biotechnology [2, 11], but the nature of the actual collaboration remains largely unclear. In this paper we therefore focus on the relationship between natural and social scientists in relation to SRI. Based on our own positive experiences with such collaborations in various settings, including corporate biotechnology R&D and academic medical genomics [9–11], we propose that ‘collaborative spaces’ are a necessity for SRI: fruitful collaborations between natural and social scientists, in which they are open to each other’s viewpoints, and understand and speak each other’s language.

The exact nature of what is being considered as ‘SRI’ depends on the context of R&D. Which social and ethical aspects are relevant, how to include them and when during the R&D process, all depends on the nature of the

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project, the prior knowledge of the natural and social scientists involved, the organisation within which they operate, and the extent to which the project is applied versus fundamental research. The answers to these questions are not self-evident and can only emerge in close collaboration between natural and social scientists, who together assess whether a particular approach was successful.

Our own collaborative practices provide some examples of how the interaction between natural and social scientists leads to broader benefits. A fermentation expert decided to use a potassium-based titrant rather than a sodium-based alternative after he and the social scientist discussed the two alternatives and realised that the environmental implications, when implemented on a large scale in a production facility, was much more favourable. In all his future research, this particular titrant was used even though it is less common in the scientific literature. In another example, a microbiologist and social scientist investigated how much arable land would be needed to produce a bioplastics precursor after the social scientist proposed the exercise to better understand the environmental implications of large-scale production of this component. Lastly, a bioprocess engineer and a social scientist discussed the implications of building a production facility on various locations throughout the world. Apart from the availability of resources and energy, the discussion also focused on labour conditions and other socio-economical factors. In the end, the engineer's proposal to his management was based not only on technical and economic considerations, but also on social and ethical ones.

As a metaphor, if SRI is the microorganism under study, collaboration between the natural and social scientist is at its nucleus: through collaboration, the natural and social scientist form the two strands of the DNA to achieve SRI (Fig 1). Similar to DNA, the two provide different, yet complementary information. In that sense, collaboration not necessarily implies the convergence of goals, but rather the enrichment of decision-making processes to achieve better results in terms of socially responsible R&D. Together, the two scientists can move beyond the question 'what is SRI?' and focus on what actually matters: considering social-ethical aspects in addition to technical and economic factors in deciding how and where

Figure 1. Natural and social scientists teaming up to reach better social scientific and natural scientific research goals. The natural scientist's R&D results are inspired and influenced by context-specific social and ethical aspects (light carrot with a dark fragment); the social scientist's results are inspired by science and technology in practice, leading to deeper insights of what SRI practically entails (dark carrot with light fragment).

to produce a certain product, and by thinking about factors such as land use or other environmental implications.

Yet, putting a natural and social scientist together into the same space is no guarantee for collaboration. Co-existence of the two does not automatically evolve into mutual appreciation, let alone fruitful collaboration. They first need "shared concepts of collaboration [...] that function as common denominators, just as the accentuated backbeat and the melody motif work together in a good rock tune" [12]. Such collaboration can only develop through a sustained, longer-term exchange of viewpoints [13].

Figure 1 depicts how we have experienced such collaboration to work in practice. To start with, the natural and the social scientist have different goals. Natural scientists are interested in solving a particular question or in the technological development of a certain product or process. Social scientists may want to obtain field data on knowledge production in R&D or improve tools to stimulate and

facilitate SRI, or include social and ethical aspects in R&D practice.

An essential prerequisite for collaboration is interaction. Prospective partners need to understand each other's language and concepts, and develop aligning goals. In our work we have found that this is a dynamic process, which requires considerable commitment and effort from both partners. Only when they are both prepared to bridge the 'gap' between them, they can understand, reflect and comment critically on one another's goals and methods. Inevitably, it takes time before they first start 'making music' together and both reach higher goals. For the natural scientist this implies R&D results that are inspired and influenced by relevant, context-specific social and ethical aspects; for the social scientist this provides an opportunity to study knowledge production as a social phenomenon and gaining deeper insights in what SRI means in actual R&D practice and. In addition, both have started to adopt and understand each other's ways of thinking through dynamic interaction. Moreover, the integration of social and ethical aspects in

R&D practice addresses the requirement for more SRI.

Social scientists can contribute knowledge on the social and ethical aspects of new and emerging science and technology, which is potentially valuable for R&D. However, the challenge for them is to find and use appropriate tools that enable natural scientists to consider these aspects at an appropriate step during the development process, and thereby translate potential value of such aspects into ‘something’ useful. This translation depends on the extent to which the social scientist is able to clarify the benefits of taking into account social and ethical aspects with relevance to the natural scientist’s goals. The social scientist should therefore both understand and speak the language of the natural scientist to be able to give constructive feedback [14].

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One of the main tools that we used to establish collaboration was ‘Midstream Modulation’ (MM) [2]. In MM, an ‘embedded humanist’—a social sciences or humanities scholar—interacts with natural scientists on a regular basis for a period of 3 months to acquire insight into the societal and organisational context of on-going R&D through dynamic dialogue. The decisions made by the natural scientists or engineers about how to further proceed with their work were ‘modulated’ into opportunities, possible alternatives and possible outcomes. The tool for such modulation is a decision protocol, which details all relevant factors and highlights the social and ethical aspects. Such ‘opening up’ of the decision-making process—to include broader considerations—generated new directions and alternatives, which further enriched the R&D decision-making on both a technical and social level [2]. As the project progressed, the natural scientists began to recognise and appreciate the value of considering social aspects.

We experienced, in our own collaborative activities, that during this process the role of the social scientist changed over time. First, we opened up to the viewpoints and concerns of the natural scientists, and learned about their tasks and problems as well as the R&D processes under investigation. Gradually, the social scientist acquired enough knowledge to ask more critical questions in relation to the relevance and benefits of integrating social and ethical aspects. This challenged the natural scientists to include such aspects in their work and, in return, learn to speak the social scientists’ language. Over time, they became more enthusiastic about participating in these collaborations.

Initially, natural scientist might dismiss social scientists, such as ethicists, and their contribution to their daily practices, for they may be seen as a brake on progress [15]. This is understandable in light of past engagements, notably in the area of nuclear energy or genetically modified organisms. Here, ethicists have been perceived to restrict the work of natural scientists, rather than enable or stimulate a broader discussion on the social and ethical aspects of R&D that facilitated a richer R&D approach. Previous ‘collaborations’ have focused much on the potential hazards and misuse of technological developments, adopting a backward-looking perspective of responsibility [7]. Not surprisingly, this ‘watchdog’ [16] notion of ethics may still linger in many natural scientists’ minds. At the same time, the social scientist also did not learn much of the actual on-going work in such approaches.

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In our collaborative endeavours we invited natural scientists to take a forward looking responsibility, looking not at potential misuse, but how to *act* responsibly with the intention to innovate in a socially responsible way [7], for instance by focusing on the actual implications of research decisions. The only way in which such forward-looking collaborative activities can be deployed, is when natural

scientists are open to the suggestions of social scientists. Since it takes time to develop a relationship that allows for mutually critical comments, collaborations can only thrive through dynamic interaction over a longer period [13,15]. Only then could and would both partners start to understand one another, and together integrate broader considerations into R&D work.

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Apart from individual natural and social scientists’ willingness to collaborate, we also learned that various other conditions could facilitate successful collaboration. These crucially depend on the organisation in which collaboration takes place. It needs to incentivise and facilitate a ‘collaborative space’ in which confidence and trust can develop [17]. Yet organisations may be hesitant to allow an external social scientist to study their R&D processes [18], and even if an organisation is open to SRI, it is not self-evident for most scientists how to combine their core R&D activities and SRI activities. The role of SRI activities in the appreciation and official evaluation of scientists remains vague at most.

In our collaborative endeavours, SRI was taken seriously by the organisations where our studies took place. The institutional culture was open to, and appreciated SRI activities, which in turn encouraged and enabled the natural scientists to successfully collaborate with social scientists. Furthermore, collaboration was voluntarily. Possibly, the success of our own activities stems in part from the fact that the participating organisations and scientists had the opportunity to ‘opt out’ and quit the programme. This warrants the question whether such collaborations would be equally successful if they were enforced, either by the organisation or through officially mandated legislation. Making collaborations mandatory could possibly put pressure on the expected outcomes, at the risk of expectations not being met. But most importantly, in our current society, SRI remains a voluntary

modus operandi in innovation practice; its full potential is currently being explored, and as such it would be too soon to make SRI practices mandatory within all R&D organisations, public and private.

We have experienced that the DNA of fruitful collaboration to functionally integrate social and ethical considerations into on-going R&D work, contains four distinct essential elements: A, G, T and C. The embedding organisation should *Aid* collaborative initiatives. The social scientist needs *Good tools* to achieve measurable effects in practice. Fruitful collaboration takes *Time* to develop. Finally natural scientists should give collaborations with social scientists a *Chance* so social scientists can in turn learn from the experience and improve SRI tools. Collaboration requires an active trial and error attitude, and only practice makes perfect.

“Voluntary collaboration between natural and social scientists is the key to SRI in a changing R&D environment in both academia and industry...”

Good quality R&D is often seen as the starting point for SRI. We would like to state the opposite, that SRI practices are a starting point for better science and technology. Voluntary collaboration between natural and social scientists is the key to SRI in a changing R&D environment in both academia and industry, where societal relevance and social responsibility are playing an increasingly predominant role. This notion of SRI goes beyond communication strategies for market introduction or assessing societal impacts of technology. The real value of ‘making music’ together is in its collaborative performance, in

its harmonium. For SRI, natural and social scientists need to play together. Preparing and waiting does not automatically generate a good ‘rock tune’ [12]. Collaboration requires an active trial and error attitude, and only practice makes perfect.

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Conflict of interest

The authors declare that they have no conflict of interest.

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