Trading-zones

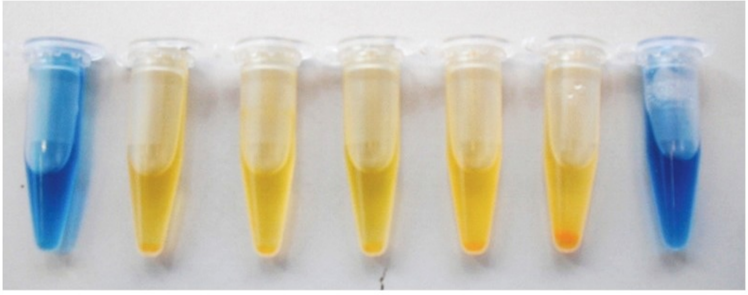
The model of "trading-zones" has been developed to discuss and explore possibilities for translating knowledge and uncertainty into responsible decision making and governance processes. It includes a set of methods for collaborations between different "epistemic cultures," meaning collaborations across disciplines and sectors, with the goal to address the uncertain and complex challenges ("epistemic other" cf. Wynne; "matters of concerns" cf. Latour), posed by synthetic biology. Points of departure are existing governance structures and societal analysis by the social sciences that may represent collective or 'real' experimentation on emerging technologies. Questions here relate to strategies for dealing with unknown and unpredictable technological developments, benefits and risks. A further focus is on political conditions that may encourage experimental playing fields on which new governance schemes can develop. Ideally, these should be able to foster new opportunities and responsibly govern potential transformations linked to synthetic biology and possibly other emerging technologies.

Collaboration Across Fields

scientists and engineers from different disciplinary cultures manage to collaborate across apparently incommensurable paradigms." Galison used the "trading zone" metaphor to explain how different epistemic communities, despite coming from contrasting scientific paradigms, were able to develop communication process. As elaborated by Pauwels (2013), the "trade" metaphor adequately captures the way academic experts meet, exchange ideas, mutually learn and return to their respective epistemic communities with concrete "goods" in the form of improved research practices. And even though Galison (1995) used this metaphor in very specific case studies in physics, the concept is now used to better understand interdisciplinary collaborations among academics, scientists, social scientists, engineers and ethicists across all fields. It is especially used in improving the lifecycle assessment (LCA) of new technologies—traditionally focused on tracking the environmental and economic impacts of a technology—with the goal to incorporating and understanding the societal impacts of emerging technologies driving towards sustainability transitions.

In addition to Galison, we would recommend the work of Knorr Certina (1999) in which she explains that the sciences can be understood as being differentiated into various "epistemic cultures" wherein different disciplines (such as physics or molecular biology, or even sub-disciplines) differ widely in their practices of "making knowledge," i.e. each discipline consists of and is constituted by sets of specific practices of generating, validating and communicating knowledge. These cultures of knowledge within each discipline also include specific practices of producing and dealing with non-knowledge, and thus can also be interpreted as "cultures of non-knowledge" (Knorr-Certina, 1999).

Case Study: LCA of a Genetically Engineered Arsenic Kit



As a real-world example, we describe a trading zone focused on the LCA of a genetically engineered arsenic test kit for detecting levels of arsenic contamination in the drinking water system in Bangladesh.[1] At the outset, we are working with a hypothesis and two assumptions. The hypothesis argues that trading zones improve predictive accuracy if diverse perspectives across disciplines are aggregated upstream in the LCA process. The two underlying assumptions for this hypothesis are: (i) diverse perspectives across disciplines need to come also from downstream actors (such as end-users of technology and policymakers) who then get an opportunity to be engaged upstream in the technology innovation process; and (ii) LCA would gain from developing new ways of assessing innovations that are pluralist, inclusive of multiple disciplines, and to a greater extent capable of mutual learning through co-evolution of diverse forms of knowledge, while maintaining a common focus of social robustness and sustainable, meaningful and responsible developments.

Going back to the arsenic test kit case study, the first step was to set up a limited group of about 15 experts in synthetic biology and technology assessment (including LCA), members from civil society organizations and regulators. One goal of this working group was to bring together the technical, regulatory, policy and civil society worlds at an early stage of product development, in this case a genetically engineered arsenic test-kit, so that concerns might be addressed upstream and during the development stage. A critical mass of the experts involved shared cross-field expertise, which allowed them to cross paradigms from life sciences to social sciences to policy and, *ipso facto*, to shape and conceptualize the discussions along these boundaries. The group gathered at several stages of the study in a kind of free-exchange with experts from the different backgrounds jointly contributing to the eventual result. They also gathered around a common underlying goal, which was flexible enough to be progressively re-framed.
The underlying goal was of “sustainability” i.e. to use LCA to detect and discuss the problem of arsenic contamination in Bangladesh and make decisions that can lead to a creation of a cheap, easy-to-

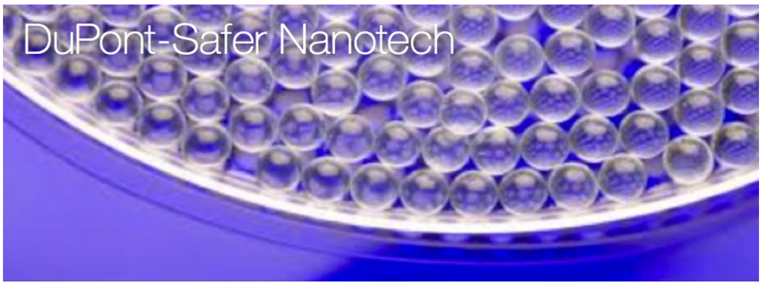
[1] The working group concentrated its effort on the LCA of an arsenic test kit based on a rE. coli chassis. The current design uses E. coli, lactose, and bromothymol blue where the presence of arsenic causes E. coli to break down the lactose and change the pH of the water, resulting in a change of the water color overnight from blue to yellow. The system uses parts that exist in nature; what is new is the combination of them together in the same strain of E. coli. The test device uses JM109, a commercially available strain of E. coli, engineered so that it cannot survive outside the laboratory and has been mutated to prevent the transfer of genes outside of itself. The device is still in the early stages of development, and the developers still envision many hurdles to overcome.

use, accurate field test. The intention of engaging experts at an early development stage was so any concerns would be mitigated upstream and also to guard against any "lock-ins" that may lead to any unintended environmental, ethical or societal concerns. The challenge in this particular example was in assessing the potential and the role of a "trading zone" in establishing cross-disciplinary collaboration between not only the scientific and engineering disciplines but also social scientists and humanities. Ultimately, they started establishing a two-way communication processes about societal, ethical, safety and regulatory issues.

Collaborating Across Sectors

Given the increasing complexity of the anticipated and unanticipated consequences of emerging technologies, one needs a systemic approach as to where certain problems affect certain end points. One recommendation to better manage, adapt to and anticipate the potential costs and benefits of synthetic biology is to work in collaboration across the different sectors (public, private and non-profit). Although these sectors (especially the private and non-profit) sectors have traditionally been adversaries, over the past few years these sectors have also come together to collectively solve complex problems. The best examples are past experiences of precedents to synthetic biology. Here we present the EDF-DuPont Nano Risk Framework, which is a watershed example of a successful cross-sector collaboration to address the challenges of nanotechnology. Lessons from historical precedents from emerging technologies—especially owing to their growing convergence—can serve as a guiding force to develop similar future collaborations in the area of synthetic biology.

Case Study: The DuPont Nano Risk Framework



The Environmental Defense Fund (EDF) and DuPont partnership is a broad collaboration of interested stakeholders to minimize, identify and address the potential environment, health or safety risks of nanotechnology, so that the society can embrace and reap the benefits of nanotechnology's promise. In 2007, EDF and DuPont launched *The Nano Risk Framework* with the purpose of proactively developing responsible nanotechnology standards in advance of government regulation. The framework was created by a multidisciplinary team from EDF and DuPont, (including experts in biochemistry, toxicology, environmental sciences and engineering, medicine, occupational safety and health, environmental law and regulations, product development and business development) to establish a process for ensuring the responsible development of nanoscale materials, which can then be widely used by companies and other organizations. In order to ensure responsible development of nanoscale materials, the framework provides guidelines for the responsible development, production, use, and end-of-life disposal or recycling of engineered nanoscale materials across a product's lifecycle.

The Nano Risk Framework has been widely distributed, recognized and broadly influential among range of companies, industry associations, NGOs and in workplaces of chemical conglomerates to tiny startups -- spanning the value chain from R&D to suppliers to retailers. Both the concepts of interdisciplinarity and cross-sector collaboration indicate that technology exists in an ecosystem, rather than in a linear pathway. The assessment process should not just be upstream but also anticipatory, iterative and flexible where knowledge is gathered from different end points. These two approaches also echo Jasanoff's concept of "technology of humility." Jasanoff explains this as "a need [for technology of humility] to complement the predictive approaches: to make apparent the possibility of unforeseen consequences; to make explicit the normative that lurks within the technical; and to acknowledge from the start the need for plural viewpoints and collective learning." According to Jasanoff, the use of technology of humility can help overcome many of the blindspots, tunnel-approach to thinking and the limits of predictive thinking.

For Further Reading and References

The above proposal is mainly extracted from the SYNENERGENE Report produced by Eleonore Pauwels and Manjyot Bhan, spring 2014. Other references include:

Pauwels, E. (2013). Metaphors and Cohabitation Within and Beyond the Walls of Life Sciences. In Early engagement and new technologies: Opening up the laboratory (pp. 207-230), N Doorn, D. Schuurbiers, I. van de Poel and M. Gorman (eds). Springer Netherlands.

Pauwels E., "Who Let the Social Scientists into The Lab?" in M. Gorman (UVA), N. Savage (EPA), A. Street (DOE) (eds), Emerging Technologies: Socio-Behavioral Life Cycle Approaches, Pan Stanford Publishing 2013.