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Collingridge's dilemma and the early ethical assessment of emerging technology: The case of nanotechnology enabled biosensors

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ABSTRACT

Early ethics assessment of technological innovations promises to produce greater sensitivity to the potential for unfair impacts and problems of consent and distrust, yet faces a key challenge: ethical issues are hard to consider in advance. For technology, Collingridge (1980) describes a dilemma in which design inevitably comes before ethical assessment since the design influences heavily how the technology will interact with society. In this paper, we review an approach we undertook to early ethical assessment of nanobiosensors adapted for traceability systems to enhance food safety and animal and plant health monitoring. The approach is based on "expert committee" methods for integrating information from a range of disciplinary perspectives. It attempts to address the dilemma of early assessment through an integrative workshop discussion of how nanobiosensors *should be* represented during public engagement. Following the workshop, we conducted a metanalysis of the discussion transcript. The metanalysis shows that while the workshop approach responds to preliminary needs for the development of ethical assessment tools and processes, it also highlights inescapable challenges of ethical analysis. We identify key challenges and discuss their theoretical implications and implications for participatory assessment. We consider workshop discussion itself, and we consider the workshop as modeling one part of a cumulative process of assessment.

1. Introduction

Researchers and policy-makers have long searched for better tools to anticipate the unwanted effects of technological innovations, and for at least four decades "unwanted effects" have included public protests against their implementation. Persistent resistance to the use of genetic engineering to improve agricultural crops and animals, continuing debates over advanced reproductive technologies like adult-cell mammalian cloning, and the uncertain future of nanotechnology and synthetic biology have increased awareness of the potential for public resistance among technical elites. While there continues to be inquiry and theory-building regarding the causes of protest and opposition to emerging technologies, other lines of scholarship attempt to address the phenomenon more proactively. Within this latter group, research on technological ethics has been especially attentive to the tension between appropriate, beneficial innovations, on the one hand, and forms of technological change that warrant opposition in virtue of their unintended, unwanted and generally unacceptable consequences, on the other.

Beginning with Hans Jonas' *The Imperative of Responsibility* [19], work in technological ethics has laid equal emphasis on methods for anticipating the outcomes of innovation more effectively and on reflective and evaluative procedures. The anticipatory emphasis of technological ethics has analogs in risk assessment and scenario planning, while the procedural emphasis overlaps with research on participatory deliberation in the social and policy sciences. Indeed, the call for public involvement and consultation in the design of technological systems was sounded among management science and operations research professionals in the 1960s. Technological ethics can be distinguished from other related forms of anticipatory and procedural scholarship primarily in its goal of stating the normative commitments that are embedded in design

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assumptions, policy frameworks and in the mindsets of various stakeholders explicitly [7]. Practitioners in technological ethics may or may not make recommendations or prescribe a given course of action, but they do emphasize clarity about when values are asserted as a rationale for choices in the design or implementation of technology. Understood as an analytic approach, ethics differs from some participatory methods for early assessment precisely in its assertion that explicit articulation of norms and value assumptions should be an important focus of the assessment process. Exploring how to assess ethical issues of emerging nanotechnologies remains an important area of inquiry, whether one believes that they will present risks of a sort that have been dealt with before or entirely new risks with which we have no experience [13,20,26,28,33].

Indeed, the belief that there is a sharp line separating R&D and the eventual deployment of technology has come to be seen as one of the implicit value judgments that needs to be placed into question in a technology ethics assessment. Contrary to assumptions that may have been operative in Jonas's approach, there is no clear moment in the evolution of a technology when decision makers can pause and review its social and environmental significance reflectively. David [9] wrote that by the time one can truly anticipate outcomes, most of the important design and development decisions have already been made. Nonetheless, scholars and policy-makers continue to call for ethical assessment at the earliest design phases of nanotechnology [3], in line with a tradition in the philosophy of technology that derives from the work of Jonas, while increasingly arguing that such assessments must engage members of the public (and especially stakeholder communities) [14,15].

Even if specific outcomes from a technology cannot be predicted with accuracy, early ethics assessment promises to create greater awareness of the potential for unfair impacts, especially among vulnerable populations. When technical elites become aware of this potential, they may become more sensitive to such impacts in their design activity. The hope is that even if an early ethics assessment is not definitive, awareness of ethical sensitivities associated with the expected trajectory of a technology could steer the design of nanotechnologies. At the same time, participatory assessment activities themselves have impacts, and the very process that is intended to improve the design and implementation of innovations can become a source of distrust. Approaches to early assessment that call for public participation are thus met with a challenge that can be understood as a specific form of Collingridge's dilemma. As will be discussed at greater length below, even an activity that is intended to fully engage and empower non-expert stakeholders must be "designed": It will not only deploy a theoretical model of an engagement process, it must of necessity provide non-expert participants with some representation or narrative of what the technology involves. Thus even "early" involvement of the public requires a *selection* of what story to tell, and as such involves value judgments that reflect assumptions about how the technology will be developed, and what might matter to stakeholders.

Ethics assessment promises to be particularly important for nanotechnologies that will be implemented within complex supply chains, such as agrifood in the United States, as there are numerous actors who may be impacted differently and whose situations designers are not aware of in advance. Advancements in food and agricultural technology have placed most food consumers in positions of both ignorance about the sources of their food and the methods of its manufacture and processing. This gap in consumer knowledge makes novel food technology vulnerable to stigmatization and social amplification of risk [35]. In order to make a very early ethics assessment of nanobiosensors applied to management of livestock disease risks, we convened a workshop among a group with expertise reflecting different points of entry to the animal products supply chain. This paper analyzes transcipts from that workshop with an eye toward accomplishing the explicit articulation of ethical assumptions and normative value judgments that has always been the focus of technological ethics.

We begin in section 2 by discussing the opportunities and challenges of early ethics assessment. Section 3, then, provides the basic background for the emerging technology explored in the workshop. This is followed, in section 4, by a discussion of why the design and implementation of this technology may pose ethical concerns. Section 5 describes the workshop method that we employed as a way of initiating early ethics assessment, and section 6 covers the results of having done the workshop. The discussion in section 7 explores dimensions that we found to complicate early ethical assessment and considers theoretical and practical implications.

2. Opportunities and challenges of early ethics assessment

As noted above, technological ethics emphasizes explicit articulation of assumptions about the putative risks, costs and benefits expected to flow from a technological innovation, as well as about patterns or methods of technology adoption or use that could have ethically significant dimensions. Much of the literature that has risen to the forefront in recent thinking on the assessment and governance of technical change has emphasized participation from members of the public and key stakeholder groups. There are at least three distinct reasons for regarding participation as important. First, developing an assessment or governance procedure that includes participation by a wide variety of stakeholders and potentially affected parties brings new *information* into the assessment process. No single body of expertise or experience can hope to capture the full range of ways in which a technology interacts with the environment and social institutions, so bringing people who are familiar with a broad range of human activities (as well as a broad knowledge of the environment) is an important way to reduce the probability of overlooking a potential outcome that would have been obvious to someone with a different body of disciplinary or experiential knowledge [18,23,29].

Second, participants bring *values* to the assessment process that might not be reflected among a professionalized assessment elite. People from different racial, class, cultural and gender backgrounds will tend to regard potential outcomes differently, hence broadening the range of perspectives included in the assessment process reduces the likelihood that the ethically most significant outcome for some important group will be neglected in the assessment process. Finally, to the extent that technologies constitute an important component of the infrastructure for modern society, decisions about technology become indistinguishable from more traditional legislative decision making with respect to their potential impact on people's lives. In this respect, participation in an assessment process becomes crucial to the *legitimation* of the ultimate decision to go forward with a given package of tools and techniques [3].

On each count, participatory approaches to early assessment augment and strengthen an ethics based assessment. Greater information broadens the basis for anticipating patterns of use and potentially adverse outcomes, while no one is better placed to express key value judgments than the affected parties themselves. Legitimation simply *is* a key norm for technological ethics. However, participatory approaches suffer from two weaknesses. First, there is no reason to presume that a participatory approach will produce the explicit articulation of ethical dimensions that has always been the focus of technological ethics. Ethical norms and assumptions are often as implicit and taken for granted among stakeholder groups as they are among technical elites [12]. There is