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The GMO-Nanotech (Dis)Analogy?

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The genetically-modified-organism (GMO) experience has been prominent in motivating science, industry, and regulatory communities to address the social and ethical dimensions of nanotechnology. However, there are some significant problems with the GMO-nanotech analogy. First, it overstates the likelihood of a GMO-like backlash against nanotechnology. Second, it invites misconceptions about the reasons for public engagement and social and ethical issues research as well as their appropriate roles in nanotech research, development, application, commercialization, and regulatory processes. After an explication of the standard GMO-Nanotech analogy, these two problems are discussed in turn.

Keywords: *nanotechnology; genetically modified organisms; societal implications; analogy*

When dealing with a matter characterized by a high degree of complexity or uncertainty, such as the social and ethical dimensions of an emerging technology, it is often useful to begin with historical analogies (Steinbruner, 2002). In the case of nanotechnology, one of the favored analogs is genetically modified organisms (GMOs). Even a cursory read of the first generation of the social and ethical issues (SEI) literature on nanotechnology reveals that the GMO analogy plays prominently in motivating and framing the discourse, if not the agenda of SEI research.[1] Consensus among science and industry communities seems to be something went wrong with society and GMOs that led to widespread public resistance to them; nanotechnology has the potential for following the same course; therefore, SEI research and public engagement are needed for nanotechnology to avoid the sorry fate of GMOs.[2] However, there are some significant problems with the GMO-nanotech analogy. First, it overstates the likelihood of a GMO-like backlash against nanotechnology. Second, it invites misconceptions about the reasons for public engagement and SEI research as well as their appropriate roles in nanotech research, development, application, commercialization, and regulatory processes. After an explication of the analogy, these two problems are discussed in turn.

The Analogy

Here is the standard reconstruction, from the perspective of the scientific and business communities, of what happened with GMOs:

1. There was a scarcity of communication between those who developed and control the technologies and the public regarding what the technologies are, their potential risks and benefits, and how the risks would be managed. When concerns were raised by members of the public, they were often ignored or dismissed; and when engagement was attempted, there was a general failure to do so in ways that addressed the concerns.
2. This lack of disclosure, communication, and responsiveness led to a public atmosphere of suspicion, misunderstanding, and susceptibility to mischaracterizations of the technologies and their risks and benefits, which organized opponents of them were able to exploit.
3. The result has been a backlash against GMOs.
4. The negative consequences of this backlash have been technological, economic, and social. It has slowed the development of new agricultural biotechnologies; it has cost the industry

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> billions of dollars in lost revenues and created international trade tensions; and it has stalled dissemination of the technologies and food to many who would benefit from them as well as stymied development of GMOs designed to benefit those most in need.

The following, then, is the general lesson from the GMO experience:

5. There are technological, economic and social reasons for open communication and early engagement with the public concerning new technologies.[3]

Application of this lesson to nanotechnology yields this conclusion:

> The scientific communities and industries involved in nanotechnology must openly confront the SEI dimensions of nanotechnology, which requires public engagement and SEI research, or they run the risk of a costly backlash against nanotechnology.[4]

There are several reasons the analogy is popular. First, as mentioned above, the use of analogy when studying the social and ethical dimensions of an emerging technology is common and often illuminating. Second, the GMO experience is recent, indeed ongoing, so it is fresh and familiar to many involved with nanotechnology and provides a familiar framework for scientists, SEI researches, and the media when dealing with nanotechnology. Third, nanotechnology is emerging in what is generally the same sociopolitical context as did GMOs.[5] Fourth, there is at present a considerable elite-public knowledge gap regarding nanotechnology as there was, and continues to be, with GMOs (Cobb & Macoubrie, 2004; The Royal Society and Royal Academy of Engineering, 2004). Fifth, some of the public interest groups and NGOs who encouraged and led opposition to GMOs have begun to scrutinize nanotechnology.[6] Sixth, as with the GMO backlash, a nanotech backlash would have significant economic, technological, and social consequences. Seventh, nanotechnology ostensibly poses many of the same types of social and ethical challenges as GMOs (e.g., managing environmental and human health risks, and ensuring distributive and participatory justice). Eighth, similar to GMOs, nanotechnology is projected and hyped to be a drastic, indeed revolutionary, improvement over its technological predecessor (hybridization in the case of GMOs and microtechnology in the case of nanotechnology). Ninth, the public is being exposed to some negative portrayals of nanotechnology (e.g., Michael Crichton's *Prey* [2002], Bill Joy's "Why the Future Doesn't Need Us" [2000], and Bill McKibben's *Enough* [2003]) as was, and continues to be, the case with GMOs. Tenth, surveys reveal that among those who have opinions about nanotechnology, many people have some of the same concerns about nanotechnology that are often expressed about GMOs (e.g., environmental and human health risks, adequate regulatory oversight, distribution of burdens and benefits, and who controls and is responsible for the technologies); (Cobb & Macoubrie, 2004; The Royal Society and Royal Academy of Engineering, 2004).[7] There are thus quite a few similarities between GMOs and nanotechnology that make the analogy attractive.

Some Disanalogies

There are, however, also a number of significant disanalogies between nanotechnology and GMOs that render nanotechnology less exposed than GMOs to public resistance and together suggest that a GMO-style backlash against nanotechnology is not as likely as the analogy supposes.

First, food-related issues are particularly sensitive for the obvious reason that food goes directly into our bodies and sustain us as well as for the less obvious reason that there are significant social, cultural, and religious aspects to food production, preparation, and consumption. Novelty in food and agriculture therefore invite public concern in ways that, for example, novelty in communication and computing technologies do not. There is also a special concern regarding the naturalness of food, and one of the primary objections to GMOs is that they are, in some unacceptable sense, unnatural (Comstock, 2000). But this concern does not attach to nonfood technologies that are already conceptualized, and accepted, as artificial (e.g., medical technologies, appliances, communication technologies). The same is true of objections to genetic modification that are grounded in beliefs about the sanctity of life (i.e., that GMOs unacceptably commodifying life or reduce it to genomic sequence) and the inviolability of species barriers (Rifkin, 1983). Each GMO offends all of these norms, whereas most nanotechnologies do not.

This is true also of the playing God and disrespecting nature objections commonly leveled against GMOs (i.e., that redesigning creation or nature according to the human conception of how it should be is to sacrilege God's benevolence and rationality or to disrespect inherent goods and intrinsic values in nature), (Comstock, 2000). These concerns have been confined, in modern western traditions, to certain contexts (e.g., natural or agricultural ecosystems and living organisms). They have not attached to technologies in contexts that are already considered artificial (e.g., medicine, communications, materials development, and electronics). So the basis of most intrinsic objections to GMOs (i.e., objections that there is something inherently wrong with them, not just something too risky about them) cannot be applied to most nanotechnologies.[8]

Nanotechnology is also less exposed than GMOs to extrinsic objections (i.e., objections that trade on probable or possible consequences of the technologies). GMOs are intended to be released into the environment through cultivation and then released into the body through consumption, whereas the challenge for most nanotechnologies is keeping them out of the environment and out of the body and is therefore a matter of containment. The exception, of course, is nanomedicine. But with nanomedicine the risks are assumed voluntarily and are confined to the person who stands to benefit from the treatment. Containment seems to many to be a more manageable type of problem than controlling something that is designed to be released; and risks assumed voluntarily by the one who stands to benefit are less objectionable than risks to those who are not intended beneficiaries and do not assume them voluntarily.

Moreover, the development of nanotechnology has an increasingly public profile and there are education efforts, SEI research efforts, and efforts to gather public input already underway (Roco, 2003; The Royal Society and Royal Academy of Engineering, 2004). There is, therefore, at least the appearance of responsible development, including efforts to provide the public with an accurate picture of the possible benefits and costs associated with nanotechnologies and opportunities for substantive public input and participation regarding those risks and benefits. There is also at least the appearance of a commitment to orient the technologies throughout the funding, research, development, and commercialization stages toward the public good. This is in contrast to GMOs, which have the appearance of being developed and controlled by powerful transnational corporations with the goal of maximizing profits as well as the appearance of being to the advantage of large monocultural farming operations and thereby the detriment of small, subsistence and family farmers (Comstock, 2000; Shiva, 1999).

So most of the concerns that people have about GMOs and most of their reasons for opposing them cannot be easily or plausibly applied to most nanotechnologies. These disanalogies therefore suggest that a broad-based opposition against nanotechnology in general is not as likely to materialize as the analogy supposes, even while opposition to particular applications or forms of nanotechnology is probable. For example, it is reasonable to expect that nanotechnologies in agriculture will face much of the same opposition as GMOs. Nanotechnologies that involve human enhancement or have military applications are also likely to encounter public resistance, so too might efforts to develop molecular manufacturing capabilities, since molecular manufacturing feeds into grey goo concerns more than particle nanotechnology and is more susceptible to the playing God and disrespecting nature objections. But as nanotechnologies continue to improve pants, sunscreen, televisions, tennis balls, paints, communications, energy production and medicine, it will be more and more difficult to organize resistance against nanotechnology, even if it will be possible to do so against nanoweapons, some nanobiotechnologies, and nanoassemblers. Moreover, one reason for cautious optimism that the GMO standoff is beginning to move away from entrenchment is the growing recognition, particularly among those responsible for regulating the technologies, that both a global opposition position and a global endorsement position are untenable (New Zealand Ministry for the Environment, 2004; United Nations Food and Agricultural Organization, 2004; UK Department for Environment, Food and Rural Affairs, 2004). Each GMO is different. They have different environmental and health risks and benefits, they distribute their burdens and benefits differently, they are designed to achieve different ends, and they are controlled and managed by different parties.[9] As a result, some are acceptable, whereas others are not. If carried over to nanotechnology, this lesson (i.e., that the details of each type of technology are crucial to social and ethical assessment) will further reduce the possibility of global resistance to them (or global endorsement of them).[10]

A Shallow Lesson and a Misleading Analogy

The lesson drawn from the GMO-Nanotech analogy is that industry and the scientific community must openly address the SEI dimensions of nanotechnology, which requires both public engagement and SEI research. This conclusion is vague. There is a range of possibilities for what adequate public engagement involves, how SEI research is framed, and how they relate to policy and regulatory decision making. Here are four points along that range.

1. The very shallow lesson: Public engagement involves allowing the public to air their concerns as well as explaining and educating the public about what the technologies are, the potential they hold, how their risks will be managed, and how they will be regulated. The role of SEI research is to facilitate this process by identifying public concerns, developing methods for effectively communicating with the public, being involved in the public education effort, and demonstrating that those who are promoting, developing, and in control of the technologies are concerned with SEI issues.
2. The shallow lesson: Public engagement involves all that is described in the very shallow lesson, as well as allowing for public participation in some decision making concerning risk management (e.g., what levels of risk [to environment, human health, and civil liberties] are acceptable and where certain facilities ought to be sited). The role of SEI research is to facilitate this process, which involves everything from the very shallow lesson as well as developing appropriate mechanisms for public participation (as described here) and ensuring that the regulatory capacity is in place to enact and enforce the resultant decisions.
3. The deep lesson: Public engagement involves all that is described in the shallow lesson as well as providing open forums or other mechanisms through which concerns about nanotechnology can be articulated, explored, and collaboratively evaluated (i.e., inclusive of representatives of the concerned public, the relevant science, industry, and regulatory communities, and SEI specialists). The results of these consultations and deliberations substantially inform not only risk management but also the research and development of nanotechnology (e.g., by setting funding priorities or establishing research and application constraints through regulation). The role of SEI research is to facilitate and enrich this process, which involves everything from the shallow lesson as well as developing appropriate mechanisms for public participation (as described here) and providing expertise on identifying, clarifying, articulating, and evaluating SEI concerns.
4. The very deep lesson: Public engagement involves all that is described in the deep lesson as well as providing forums in which the public's desires for nanotechnology, both positive and negative, can be articulated, explored, and collaboratively evaluated. It is through such democratic processes that the objectives for nanotechnology, not just funding priorities or constraints, are set. Once these objectives, and the constraints on how they can be pursued, are identified, the scientific community and industry can attempt to develop economically viable technologies that realize the objectives within those constraints. The role of SEI research is to facilitate and enrich this process, which involves everything from the deep lesson as well as developing appropriate mechanisms for public participation (as described here) and providing expertise on identifying, clarifying, articulating, and evaluating possible objectives for, and constraints on nanotechnology research and application.

Where along this continuum does the lesson from the standard GMO-Nanotech analogy fall? On the shallow end. The emphasis is not on orienting the technologies around a publicly defined set of objectives but, much shallower, avoiding a certain kind of public response. Avoiding a backlash is considered to be for the social good, as well as the economic and scientific good, but this is not a determination that the public has helped make, as the deeper end would have it. Moreover, the problem in the GMO case is not taken to be the technologies or their consequences but the general public's ignorance and misconceptions about them as well as the lack of effective effort on the part of GMO proponents to first preempt and later dispel the public's largely unjustified concerns. SEI research and public engagement on nanotech are enlisted to forestall those problems. So it would seem that the standard analogy favors a shallow understanding of the lesson.

But the shallow lesson is troubling. The proper end for nanotechnology, as with all technologies, is to promote human welfare in a just and sustainable way. The reason for doing the SEI research and engaging the public is that there are potential Social and ethical Issues associated with nanotechnology, and if the technology is to do what it should (i.e., contribute to human welfare in a just and sustainable way) those need to be identified, discussed, and addressed. Moreover, although the scientific community has technical expertise and industry Community has economic expertise, they do not have, in virtue of their being expert in science or business, either expertise in the social and ethical dimensions of technological innovations or the standing to claim to represent the public's views about them.

The analogy therefore seems to get wrong, or at least privilege the wrong explanation for why

SEI research and public engagement are important. It frames SEI research and public participation as primarily aimed at public acceptance, when their proper justification and objective are quite different. Encouraging public understanding and reflection regarding new technologies so that people are better positioned to make informed choices about them is one way in which SEI research and public engagement can help ensure that technological innovations promote human welfare. However, that is different from suggesting, as the analogy does, that securing public acceptance of emerging technologies should be the focus and orient the agendas of SEI research and public engagement. Perhaps the public, or some subset of it, will have strong social and ethical reasons for rejecting certain forms or applications of nanotechnology or good reasons against letting nanotechnology proceed to application and commercialization before adequate regulatory capacities, decision-making mechanisms, or oversight are in place. It cannot be assumed from the beginning that all of the public's concerns about nanotechnology will either be based on misconceptions, and therefore are appropriately addressed through education and outreach, or be risk management problems that are best left to the experts.

Conclusion

The point is not that those who employ the analogy intend the shallow lesson or believe that the primary role of SEI research and public engagement is merely to pave the way for their acceptance rather than explore possible problems and methods of remedy that should inform nanotechnology's development and dissemination. It is that the analogy favors this interpretation as a result of its motivating SEI research and public engagement out of a concern to avoid public resistance. It thereby obscures the reasons for public engagement and SEI research, their proper focus and objectives, as well as their appropriate roles in nanotech research, development, application, commercialization, and regulatory processes. This is not to claim that studying the GMO backlash or other SEI dimensions of GMOs is not at all useful for understanding the social and ethical challenges associated with nanotechnology. It is only to recognize that the analogy between them that trades on the possibility of a public backlash against nanotechnology is not as strong or as helpful as its ubiquity would suggest. So although the analogy is a powerful rhetorical device for getting people to think rightly that SEI research and public engagement regarding nanotechnology are important, it has the potential to confuse about what the reasons for that are as well as how they should be framed and oriented. The GMO-nanotech analogy therefore needs to be employed advisedly.

Notes

1. The analogy appears in scholarly articles, congressional testimonies, popular articles, public lectures, opinion pieces, and government publications: for example, Brumfiel (2003); Colvin (2003); Giles (2003); Gorman, Groves, and Catalano (2004); Mnyusiwalla, Daar, and Singer (2003); Kulinowski (2004); Mehta (2004); Moore (2002); The Royal Society and Royal Academy of Engineering (2004); Sweeney, Seal, and Vaidyanathan (2003); Wilsdon (2004); Wilsdon and Willis (2004); and Woodhouse (2004).

2. There are several alternative interpretations and reconstructions of the GMO experience. For example, some consider it a successful grassroots social movement against powerful transnational corporations in defense of the public good. However, it is the formulation articulated above and elaborated on in what follows that has motivated interest on the part of science, industry, and regulatory communities in SEI research and public engagement.

3. "Early and open discussions of the societal and ethical impacts of new technologies improve their staying power, save taxpayers money, and benefit our society" (Colvin, 2003).

4. Here are a couple representative statements of this lesson:

> We believe that there is a danger of derailing NT if serious study of NT's ethical, environmental, economic, legal, and social implications . . . does not reach the speed of progress in the sciences… The only way to avoid such a moratorium [on nanotechnology] is to immediately close the gap between the science and ethics of NT. The lessons of genomics and biotechnology make this feasible. Either the ethics of NT will catch up, or the science will slow down. (Mnyusiwalla et al., 2003, pp. R9, R12)

> No nanotechnologist wants the field to go the way of GM foods, which are largely viewed as the poster child for misguided public policy. With sound technical data about nanomaterials' health and environmental impacts and a commitment to open dialogue about potential social and ethical implications with all stakeholders, nanotechnology could avoid traveling along the wow-to-yuk trajectory. (Kulinowski, 2004, p. 19)

5. This point is emphasized by Moore (2002), who highlights the following: affluence levels sufficient to allow discriminating decisions about new technologies, the pervasiveness of technologies, the high rate of technological change, widespread acceptance of the importance of individual choice, public demandingness for greater accountability and evidence on unintended and unwanted consequences of new technologies, and the rapid pace at which SEI discussion can proceed and opposition form.

6. Prominent among these is the ETC Group, formerly Rural Advancement Foundation International, which has advocated shutting down research and development of molecular manufacturing and a moratorium on the commercial production of new nanomaterials (ETC Group, 2003).

7. There are even additional concerns about nanotechnology, beyond those in common with GMOs, that arise because of the

broader range of applications of nanotechnology (e.g., threats to civil liberties and the development of destructive technologies); (Cobb & Macoubrie, 2004).

8. That many of the central objections to GMOs are intrinsic objections belies the view, represented in the standard GMO-nanotech analogy, that what went wrong with public discourse about GMOs was primarily a lack of communication about risk (and risk management) and benefits (and their distribution). This point is emphasized by Wilsdon and Willis (2004).

9. Compare, for example, GM creeping bentgrass, which has been engineered to provide better fairway grass for golf courses and has high environmental risks (because it is easily dispersed given its light pollen, it grows vigorously it is highly outcrossing, and it is engineered to be resistant to Roundup herbicide), with golden rice, which has been engineered to help provide beta-carotene (the precursor to vitamin A) to enhance the diets of millions of children who are at risk for blindness and disease because of extreme vitamin A deficiency and has much lower environmental risks (because it is less easily dispersed and the engineered trait does not appear to confer any fitness advantage in the wild).

10. Of course, it is possible that opposition to GMOs carries over to nanotechnology through social and psychological inertia. The point of this section is not to deny this possibility but to show that it is significantly less likely than has standardly been supposed.

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