Ethics and the Development of Nanotechnology[1]

Hugh Lacey
Swarthmore College / Universidade de São Paulo
hlacey1@swarthmore.edu

1

I have little to contribute directly to ethical reflection that specifically deals with risks that might be occasioned by innovations of nanotechnology (Schummer, 2007; Shelley, 2006), and with how to promote responsible conduct and public trust in the face of them (Weil, 2006). Instead, I will introduce a **general ethical stance** towards technoscientific research and innovations, one that I have developed over the past several years while writing about ethical issues of agricultural biotechnology (Lacey, 2005, 2006a). It has implications for thinking ethically about nanotechnology.

The general ethical stance is that it is *irresponsible* to engage in the kind of research – e.g., in biotechnology or nanotechnology – that leads to technoscientific innovations, *unless* commensurate systematic and rigorous research is also conducted on the long-term ecological and social consequences (risks) of implementing them, taking into account the socio-economic conditions of the planned implementations, and *unless* adequate research pertinent to appraising the general social value (benefits) of the implementations is conducted.[2] It requires that ethical responsibilities be explicitly exercised from the outset of research. It pertains to research priorities (and also to methodological choices – Lacey, 2005; 2006a). It is not a reactive stance – one, where ethics comes into play only after priorities have been set and results have been obtained (see Lacey, 2007).

Like the 'Precautionary Principle' (PP) (Lacey, 2006b, and the many references listed there), this stance (1) proposes caution and delay in the face of technoscientific innovation, pending (2) conducting research in areas that cannot be investigated adequately using only the research methodologies that lead to technoscientific innovations, and explain their efficacy (see Note 14). I have in mind, here, conducting relevant ecological, social and other studies on anticipated risks, not only short-term risks occasioned by biological, chemical and physical mechanisms, but also those occasioed by socio-economic mechanisms. "Risk" is obviously a value-laden term. What is considered a risk for one ethical perspective may be of no concern for another.[3] PP identifies the risks that should be investigated in the light of ethical judgments that concern (among others) universal human rights, environmental responsibility, sustainable development, inter- and intra-generational equity,[4] and participatory democracy.

2

Why do I propose adopting such an ethical stance?

My answer has its roots in five phenomena of scientific practices and their history.

1. Reliable knowledge that informs efficacious applications: Modern science has

[1] Round-table, with Alfred Nordmann, IV International Seminar: Nanotechnology Society and Environment, Vitória, ES (Brazil), August 6, 2007.

[2] Cf. " … there is a strong need for integrated research that includes ethical and sociological research to understand the impact of both the intended and the unintended technological results on society, and that combines goal-orientated and harm-preventing technological research" (Schummer 2007: p. 95)

[3] Threats to profits are serious risks where the values of capital and the market are held, but not where the values of popular agricultural movements are held; whereas to the latter, but not to the former, the demise of small-scale farming is a serious risk.

[4] Schummer (p.89) refers to "the principle of sustainability so that future generations will not suffer from a lack of resources and an abundance of unusable waste".

produced an enormous stock of reliable knowledge and understanding of phenomena of the world, and of the processes, interactions, structures (and their components), and laws underlying them. Moreover, a good deal of it has been used to inform efficacious applications in technology, medicine and other areas. These applications, which are widely valued positively, have contributed greatly to fundamentally transform the world we live in, by way of enhancing human powers to act, to reshape material objects, and to solve problems that hitherto had remained intractable.

2. Environmental crisis: The current environmental crisis, with its (sometimes) devastating human and social dimensions, is among the consequences of certain kinds of scientific knowledge having been technologically applied under the socio-economic conditions that have been characteristic of modernity. *Science has not produced the knowledge that would be needed to deal adequately with this crisis, and it is only now beginning to understand its extent and dimensions.* Note: Implementing technoscientific innovations has caused significant harm, e.g., global warming, and ecological/social devastation caused by the Green Revolution. Talking about risks, therefore, is not just speculative and engaged in for 'ideological', 'anti-scientific' motives; it is important for everyone, including those who judge that the benefits of technoscientific innovations far outweigh the harm their unintended (and often unanticipated) side-effects have caused.

3. Inequity of the distribution of scientific 'goods': The benefits of applied science have not been distributed evenly among rich and poor peoples and countries – so much so that, under the socio-economic conditions of application, many poor people have suffered greatly from the disruption of their lives brought about by implementations of applied science. More generally, addressing the problems of the poor has not been a high priority of applied science and, often enough, scientific "solutions" that are offered for their problems (e.g., hunger and malnutrition) are implemented without empirical analysis of the causal nexus of the problems, and hence it often leaves this nexus in place, thus failing to deal with the problems or even exacerbating the sufferings of the poor.

It is important to locate these three phenomena in the context of the next two.

4. Values embodied in scientific practices: The tradition of modern science has maintained that the practices of scientific research embody certain values. One of them is *objectivity*: a hypothesis becomes accepted as scientific knowledge only when it has been tested in the course of an appropriate rigorous program of empirical (often experimental) research and judged to be well supported by available empirical evidence in the light of strict cognitive criteria (e.g., empirical adequacy, explanatory and predictive power) that do not reflect particular ethical or social values. A second is *autonomy*: matters of scientific methodology and the criteria for evaluating scientific knowledge are outside of the purview of any ethical (religious, political, social, economic) outlook or personal preferences; the priorities of research, for the scientific enterprise as a whole, should not be shaped by a particular value outlook; and scientific institutions should be constituted so as to resist external (non-scientific) interference. Yet a third is *neutrality*: scientific results, considered as a whole, do not support some ethical value outlooks at the expense of others, either by way of their logical implications or of their consequences on application.

5. The growth of 'private interest' science: In our times, the socio-economic conditions of scientific research are rapidly changing. More and more, large technoscientific corporations and other commercial interests are funding scientific research, and government sponsored research increasingly tends to prioritize research that can be expected to have applications that will have reasonably short-term economic benefits (Krimsky, 2003). One of the consequences of this is that there has been a marked change in emphasis in how the aims of science are conceived. Throughout the history of modern science, these aims (reflected in phenomenon 1) have covered a spectrum, whose endpoints are defined by understanding and practical utility (technological and industrial applications, medical innovations, etc). Increasingly the emphasis has shifted towards

the practical utility endpoint, with commercial and military interests shaping the priorities of research. Increasingly research is for the sake of discovering more of what we are able to do in exercising control over natural objects and how to enhance and expand what we can do – how to develop technoscientific innovations and nurture their penetration into more and more domains of experience and social practice.

3

Nanoscience exemplifies the move towards engaging in scientific research for the sake of expanding the domain in which technoscientific control is possible.

Our colleague in this round-table, Alfred Nordmann, has written:

> … nanoscience is an exploratory attempt to claim foreign territory and to inhabit a new world or a hitherto unexplored region of the world. Epistemic success is therefore a kind of technical achievement, namely the ability to act on the nanoscale, that is, to see, to move around, move things around, carve your name into a molecule, perhaps initiate productive processes, in other words to inhabit inner space somewhat in the manner we have begun to inhabit outer space and certainly as we have conquered the wilderness (Nordmann, 2004, p. ••).[5]

The introduction of transgenics was like that too. It followed research that asked questions like: "What traits can be engineered into plants? Which ones can be commercially exploited? Can using transgenics augment crop productivity and profits more, and more efficiently, than using 'conventional' agricultural methods?" Only later, as objections were raised about ecological risks and who the beneficiaries might be, was the authority of science sought to quiet fears about risks – which, as in the case of nanotechnology, were often exaggerated out of all proportion, and this led to efforts to dismiss out of hand those who raised serious queries about risks (discussed in Lacey 2006a: Appendix). And then the following question also was asked: "How can the results of transgenics research be used to deal with the problems of small-scale farmers (e.g., production in poor agroecosystems) and their communities (e.g., hunger and malnutrition) in impoverished countries?" Compared to the resources put into research on what we can do with transgenics, very little was put into research reflecting this last question.

My point, however, is not to complain that if transgenics research had taken on different priorities (shaped by humanitarian rather than commercial interests) the interests of poor peoples and countries would have been well served. Maybe they would have. Or, maybe using transgenics can have no major role apart from commercial interests. Whatever it may be, as research and development of transgenics unfolded, it was just taken for granted that transgenics would have to be a major component of the agriculture of the future – we can genetically modify agricultural plants, let's do it for the sake of the poor! (A point like this is often made in connection with developments of nanotechnology.[6])

---

[5] Cf.: "Nanotechnology is … focused on the creation of functional materials, devices and systems through the control of matter on the nanoscale, and the exploitation of novel phenomena and properties on that scale" Mnyusiwalla, *et al.* (2003): 9.

[6] " … the main issues for developing countries were poverty reduction, energy, water, health and biodiversity. Nanotechnology can contribute to all of them' (Mnyusiwalla, *et al.*, 2003: p.11). I am skeptical of assertions like this that speak of what a technology can be used for to deal with problems facing the poor, *while not engaging in an analysis of the causal nexus that maintains the problems*. That can lead to endorsing technoscientific developments, sponsored by commercial interests, which can in fact only be implemented under the conditions favored by these interests. (See my discussion of 'golden rice' in Lacey, 2006a: Section 3.3.) In this context Schummer's advice should be followed: "Before discussing ethical issues of nanotechnology, it is important to understand the social context in which it emerged, including its various traditions, meanings, stakeholders, protagonists and critics, as well as what researchers are doing in their laboratories" (Schummer, 2007: 80).

My point is quite different, *viz.*, that transgenics were not developed in the context of considering empirically the questions: What agricultural methods – ‘conventional’, transgenic, organic, agroecological, biodynamic, subsistence; and in what combinations and with what variations – *could* be *sustainable* and *sufficiently productive*, when accompanied by viable distribution methods, to meet the food and nutrition needs of the whole world’s population in the foreseeable future? Are there alternatives with productive capacity at least as great as that of transgenics methods? Are there alternatives that can meet food and nutrition needs in contexts where transgenics methods may have little applicability? Do transgenics methods themselves really have the potential to play a major role – sustainably – in meeting the worlds food and nutrition needs? What evidence supports the proposed answers? Moreover, implementing the developments of transgenics were not even delayed pending addressing the question: What are the possibilities open to transgenic technology in the light of risks, alternative agricultural approaches, and who might or might not benefit from them?

The impetus to develop transgenics was primarily commercial. They were not developed in response to a scientific consensus that they were needed – and there was little interest in developing them apart from agribusiness corporations and the scientific institutions that were funded by them. They were introduced because we could intervene genetically in order to make them, and they proved to be useful for the commercial agenda. They were introduced in a social context in which showing that they were possible, and that using them (in the intended ways) is efficacious, were taken to be sufficient to legitimate using them. (If we can do it – and get funded to do it – it’s ok to do it! And we can deal with any harmful consequences if and when they arise!)

Nanotechnology is being developed in the same kind of context,[7] not one in which the question of what priority should be accorded to nanotechnology research is addressed by taking into account who are the expected beneficiaries and what these people might gain if other kinds of research were prioritized. It is as if it is taken for granted that implementations of nanotechnology are inevitable, so that the only thing to do is find ways to regulate it so as to minimize potential harm and find ways to use it for the sake of the poor.

4

In this context PP is rejected. But that does not mean that the scientific research is free from ethical input that pervades its every moment. In this context, research is actually conducted under the aegis of a principle that I call **the principle of presupposing the legitimacy of technoscientific innovations (PLT)**: *Prima facie*, it is legitimate to implement a technoscientific innovation, provided that it is informed by soundly accepted scientific knowledge (accepted in accordance with *objectivity*) – or, normally, unless there exists scientific evidence that there are serious risks, it is legitimate to implement – *without delay* – efficacious applications of objectively confirmed scientific knowledge.

Alfred Nordmann, in his presentation to this round table, maintains that (in these respects) nanotechnology has been different from transgenics. Regarding nanotechnology, he suggests, a ‘visionary outlook’ grounded in admirable ethically grounded aspirations has preceded research and development. I do not doubt that motivations for engaging in research and development of nanotechnologies have been stated in such ways (and that early discussion of ethical issues of nanotechnology has been encouraged by funding agencies). However, I repeat that I am skeptical of such ethical discussion, unless it takes the causal nexus of the problems to be dealt with into account, and unless it defines the problems in such a way that it can be investigated whether nanotechnologies offer better solutions than alternative proposals. (Clearly there is much more that needs to be discussed here.)

[7] Those who may have real stakes in its outcomes have not been seriously consulted about innovations in nanotechnology. The question ‘what can be done with nanotechnology?’ has not been made subordinate to ‘What are the problems of the poor that really need to be solved?’ and ‘What are the various ways in which these problems might be addressed – taking into account their social causal nexus?’

I doubt that any of those involved in implementing technoscientific innovations have actually formulated the principle, PLT, consciously proposing it as an ethical principle. It un-self-consciously pervades the discourse of legitimation of technoscientific innovations; it is taken for granted without reflection or comment that businesses and their scientific employees act in the light of it. It shapes the priorities of research, legitimating giving overwhelming priority to the research that gives rise to technoscientific innovations, and usually only lip-service (or a relatively small budget) to the need to investigate risks, and – in the case of agriculture, and probably medicine too – rejecting the need for investigation of the possibilities of alternative practices (e.g., agroecology) that do not draw centrally on the results of technoscientific research.[8] Risks, we hear repeated in their legitimating discourse, are endemic to innovation (and our society has staked itself on constant innovation) – and the risks of implementing technoscientific innovations pale into insignificance compared to the risks of 'being left behind' in the international economy or in contributing to scientific developments. I note in passing that this is, in part, an empirical claim, but I don't recall ever seeing any empirical investigation made of it.

In a recent issue of *Folha da São Paulo*[9] a UNICAMP scientist, Oswaldo Alves, is quoted as saying: "In the world today approximately 450 nanotechnology products are being used", including products connected with electronic equipment, cosmetics, food and medicine; but he points out that there has been little investigation made of the risks they may occasion. Large-scale implementation has occurred without commensurate investigation of risks. These nanotechnology products have simply been introduced into the market, in response to market conditions and expectancies, before we know very much about their environmental impact and the risks that might be involved – thus before having a sound basis for their ethical legitimacy.[10] This does not mean that the implementers do not care about their ethical legitimacy. They take it for granted. This reflects the grip of PLT on contemporary consciousness and conscience.

5

I emphasize that PLT, like PP, is an ethical principle. (*Legitimacy*, like *responsibility*, is an ethical concept.) To advocate following PP is not to propose a role for ethics in science, where currently there is no role; it is to advocate following PP in place of PLP. Like it or not, consciously or not, research priorities and methodologies do reflect ethical principles. PP, its proponents think, is a 'better' ethical principle than PLT to guide technoscientific research and development

In opposition to PP, PLT puts the 'onus of proof' about risks on those who think that risks should be fully and rigorously investigated before the social implementation of an innovation – an onus that cannot be borne given the research priorities of those who hold PLT and the fact that their influence dominates current scientific institutions. In that context, one often sees the unsound inference being made from 'there is no available scientific evidence that there are serious risks' to 'there is scientific evidence that there are no serious risks' (see Lacey, 2006a: Sections 4.3, 4.4). And also, in that context, making the issue difficult to discuss critically, rather than an explicit formulation of PLT, we find in play what amounts almost to an *ethical imperative*: prioritize technoscientific 'solutions' to the great problems facing the world, e.g., malnutrition in poor countries, combined with the insinuation that it is an *ethical deficiency*, not only to cast doubt on the legitimacy of research and development that might lead to such 'solutions', but also to propose that the investigation of risks should take into account the socioeconomic relations involved in implementing the 'solutions' (see Note 12).

---

[8] Where PLT is taken for granted, the role of ethical discussion is little more than to contribute to grounding the sense that implementations of nanotechnological innovations are ethically legitimate.

[9] "Impactos da nanotecnologia são ignorados", *Folha de São Paulo*, August 1, 2007, p. A12.

[10] What kind of argument would support that the benefits of using nanotechnology for cosmetics warrant taking the risks – as yet largely unknown – of releasing nanoparticles into the environment?

The grip of PLT is, I think, easy to understand and hard to avoid. The rationale for it is deep in a value outlook that has always been close to the developments of modern science. This outlook incorporates what I call *the values of technological progress* (VTP).[11] They include: according high ethical and social value to expanding the scope of the human capacity to exercise control over natural objects, especially as embodied in technoscientific innovations, to innovations that increase the penetration of technologies (objects, systems, solutions to problems) ever more intrusively into ever more domains of modern (daily and domestic) lives, experiences and institutions, and to the definition of problems in terms that permit technoscientific solutions. VTP also involves not subordinating the value of control of natural objects systematically to any other ethical and social values but, on the contrary, according *prima facie* legitimacy to implementing technoscientific innovations, even tolerating a considerable measure of social and environmental disruption for its sake.

Holding VTP is rendered coherent and rationally justified by appeal to presuppositions like the following. (a) On-going technoscientific innovation expands human potential and provides benefits that can be made available to all human beings. (b) Technoscientific solutions can be found for virtually all practical problems (in medicine, agriculture, communications, transportation, energy provision, etc), including those occasioned by the 'side-effects' of technoscientific implementations themselves. (c) For most of these problems there are only technoscientific solutions. (d) The values of technological progress represent a set of universal values that must be part of any viable value outlook today – *there is no viable alternative*. (For fuller accounts of VTP and its presuppositions, see Lacey, 2005: Chapter 1; 2006a: Introduction.)

With the growing influence of private-interest science (phenomenon 5, Section 2), the aim of scientific activities has shifted so that it has become (for many) simply to further the social embodiment of VTP. This undermines the *autonomy* of science (see phenomenon 4) by subordinating its activities largely to commercial interests, and this in turn makes it unlikely that the interests of the poor will be commensurately addressed, and so unlikely that the value of *neutrality* can be more fully realized. It even poses a threat to *objectivity*. Proposals,like the presuppositions of VTP become treated as truisms, rather that properly being subjected to empirical research and so – contrary to the value of *objectivity* – proposals are accepted in the name of science although relevant evidence has not been obtained for them. Likewise, the authority of science is often misused especially when it speaks about technoscientific innovation (and this certainly includes nanotechnology): its **risks**, its **promises**, and **alternatives** to it (cf. Krimsky, 2003). When it is put behind "there is no scientific evidence that there are serious risks", e.g., it often misleads by insinuating that compelling scientific evidence supports that there are no significant risks.[12] When put behind, e.g., "we are on the verge of solving the food and

---

[11] The enthusiastic acceptance of VTP at the outset of modern science, and even until quite recently, is readily intelligible, for then a prospect apparently full of promise was opening up. Now, we have to take into account the phenomena of the environmental crisis and the inequity of the distribution of the benefits of applied science (phenomena 2 and 3, Section 2 above).

[12] See Lacey (2006a: Chapter 4) for discussion of this point in connection with the transgenics case. There I also discuss how standard risk analysis investigates only risks occasioned by transgenics, *qua* biological objects and in view of the physical, chemical, biochemical and biological mechanisms in which they can be implicated, but that it does not consider risks occasioned by them *qua* socioeconomic objects (e.g., commodities, patented objects). But transgenics are not only biological objects, but also (in most cases) commodities; and often a transgenic (biological object) exists only because of its socioeconomic role. The social relations of production of transgenics technology (and the knowledge that informs it) are the same as those of its use (with little qualification needed in order to take into account that some transgenics research is conducted by scientists with genuinely humanitarian motivations). It is not just a matter of the uses to which transgenics technology can be put, as if certain risks derive, not from the technology itself, but from

nutrition problems of the poor in developing countries", it counts on its audience to assume (falsely) that there is strong evidence to support this, although the confidence expressed in statements like this only reflects (unconfirmed) expectancies, or mere hopes, that 'technoscience will deliver'. And, when put behind 'there are no alternatives' it comes perilously close to identifying this with 'there are no alternatives within the trajectory of capital and the market' (Lacey, 2006a: Section 5.6). In these situations, the discourse of science becomes barely distinguishable from the rhetoric of advertising – as if the point of making the statements were to produce certain desired effects (or to counter opposition) regardless of whether they had been tested in accordance with *objectivity*.

7

My suggestion is that the role played by PLT not only is in opposition to the recommendations of PP, but also that it poses threats to the traditional values of modern scientific activity: *objectivity*, *autonomy*, and *neutrality* (phenomenon 4). [13] [I have heard it said that these values are outmoded, given the way in which science is now conducted. There may be something to this. But, separated from the ideal of *objectivity* science loses its claim to authority in public discourse.] PP, I suggest, leads to scientific practice that better strengthens these traditional values of science.[14] And I would go beyond PP and suggest, not only for ethical reasons but also for the sake of the integrity of science, that we need to find a way to respond seriously and communally to the question: "how should scientific research be conducted so as to ensure that the integrity of nature might be respected and the well being of everyone everywhere enhanced?"

---

the uses to which it is put. A transgenic is just one object, simultaneously biological and socioeconomic, and the scientific community bears responsibility for all its anticipated and foreseeable uses. (I leave as an open question how these considerations may generalize so as to be relevant to the transgenics case.)

[13] Scientific institutions may lack the power to entice corporations to follow PP. We should have no illusions on this score. But that does not mean putting aside the traditional values of science for the sake of providing propaganda for technoscientific innovations, whose risks have not been adequately investigated and where alternatives (not involved in that technoscientific innovation) have not been considered. It is the responsibility of science to be clear about what is and is not well supported by scientific evidence, and what has not even been investigated – that is the way for science to contribute properly to the social/political debate. Often it is said that our society has chosen to take the risks occasioned by technoscientific innovations. Well, then, be upfront about this! There are risks, largely unknown, and so the authority of science subverts itself when it suggests that there are no serious risks. [And, regarding presupposition (b) of VTP, how does it stand up in the light of phenomenon 2? Can we assume that technoscience is developing so that it will be able to take care of the harmful side effects of its applications?] Science should not hide an issue of social 'choice' behind a cloud of allegedly established scientific results. Scientific organizations, I submit, should attempt to reclaim (no doubt under redefinition) the value of *autonomy* of science, so that science sets its own priorities, or at least openly debates what they should be, and seek support for funding in the light of their conclusions, instead of deferring to the interests of current funders (commercial interests and their government allies), and then (after the fact) trying to limit the damage.

[14] The general ethical stance that I propose (Section 1) is stronger than PP. It proposes that it is irresponsible to engage in technoscientific research, not just to push ahead with implementations of technoscientific innovations, unless the conditions stated in the second paragraph of the paper are satisfied. I prefer the stronger stance, in part because PLT is pervading the context of technoscientific research, so that doing the research is accompanied by the assumption that it is legitimate to implement innovations.

References

Dalcomuri, Sônia Maria (2006) "Inter-relações fundamentais para o desenvolvimento sustentável", In Martins (2006), pp. 49–68.

Krimsky, Sheldon (2003) *Science in the Private Interest: has the lure of profits corrupted biomedical research?* Lanham, MD: Rowman & Littlefield.

Lacey, Hugh (2005) *Values and Objectivity in Science*. Lanham, MD: Lexington.

Lacey, Hugh (2006a) *A Controvérsia sobre os Transgênicos: questões científicas e éticas*. *São Paulo*: Idéias e Letras.

Lacey, Hugh (2006b) "O Princípio de Precaução e a autonomia da ciência", *Scientia Studia* 4 (3): 373–392.

Lacey, Hugh (2007) "The ethics of science and technology," in Carlos Galles & Pablo Lorenzano (eds), *History and Philosophy of Science and Technology*, a volume of *Encyclopedia of Life Support Systems* (*EOLSS*). Oxford: UNESCO Publishers–EOLSS publishers [http://www.eolss.net] (in press).

Martins, Paulo Roberto (2006), ed. *Nanotecnologia, Sociedade e Maio Ambiente*. São Paulo: Xama.

Mnyusiwalla, A., Dear, A.S. & Singer, P.A. (2003) "'Mind the gap': science and ethics in nanotechnology," *Nanotechnology* 14: 9–13.

Nordmann, Alfred (2004) "Molecular disjunctions: staking claims on the nanoscale", in D. Baird, A. Nordmann & J.Schummer, eds. *Discovering the Nanoscale*. Amsterdam: IOS Press.

Schummer, Joachim (2007) "Identifying Ethical Issues of Nanotechnologies", in: Henk ten Have (ed.), *Nanotechnology: Science, Ethics and Politics*, Paris: UNESCO Publishing.

Shelley, Toby (2006) *Nanotechnology: new promises, new dangers*. London: Zed Books.

Weil, Vivian (2006) "Introducing standards of care in the commercialization of nanotechnology", *International Journal of Applied Philosophy* 20 (2): 205–213.