

Risk and Risk Perception of Nanotechnology

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Nanotechnology is now widely believed to be one of the most influential techno-sciences of the future. Or at least it is believed that way in most of industrial countries including South Korea. Naturally, the governments of these industrial countries are currently investing a sizable portion of their human and material resources in order to go ahead in this prominent area of research. Consequently, nanotechnology in these countries has become one of the social sectors where reasonable accountability is normally called for. I claim that reasonable accountability of nanotechnology should take into account the risk-perception of citizens as regards nanotechnology as well as its risk itself. Risk-perception could be variable, changeable, and prone to be polarized; still we should pay more attention to public risk-perception because it is clearly effective in mobilizing public movements, objective in the intersubjective way, and legitimate in a democratic society.

Keywords : Nanotechnology, Accountability, Risk, Risk-perception, Democratic society

I. Introduction

Nanotechnology as an emerging technology has its share of enthusiastic advocates as well as sceptical critics. The advocates talk about a fairytale-like nanoworld especially through mass media and public imagination, where nanomachines will be navigating around inside our bodies, diagnosing and treating diseases or re-arranging our brain circuits [1,2]. Usually the researchers are more cautious, anticipating the expansion of our knowledge into the nano region but acknowledging (admittedly, in some cases half-heartedly) the potential risk factors of nanotechnology research. And there are staunch critics of nanotechnology, fearing the arrival of a global disaster resulting from massive nanoparticles released in the air or something more subtle such as the sys-

tematic infringement of individual privacy which will become technologically possible thanks to a variety of information-gathering nano-devices [3,4].

Despite the disparity of opinions on nanotechnology, it is uncontroversial to say that nanotechnology will be one of the most influential techno-sciences in the future. We as the general public (not just nanotechnology researchers or a restricted group of users) are going to be affected by the technology on daily basis. Or we might not if we decide to stop developing nanotechnology for some reason.

But the international moratorium of nanotechnology research is unlikely because most of industrial countries including South Korea deeply believe in the importance of nanotechnology in the future society, and are currently investing a sizable portion of their human and material resources in or-

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der to go ahead in this prominent area of research. Moreover the decision to put huge efforts into nanotechnology research seem reasonable, considering the scale of impact nanotechnology is expected to give to related industrial production [5,6].

Given that there are relatively uncontroversial, not-yet-realized but potential benefits we may expect from nanotechnology research and that there are also relatively uncontroversial, fortunately not-yet-realized but potential risks of nanotechnology we may have to deal with in the future, a rational thing to do looks clear. We may allow researchers and policy-makers to continue their nanotechnology research, while asking them to pay enough attention to the issue of safety, health-risks and other ethical considerations in their development of nanotechnology. In this respect, the balance of gathering potential benefits and guarding against potential risks is crucial [7].

There is another dimension of our concern on nanotechnology research. In most of the countries where public resources are employed in the nanotechnology research, we have to recall an obvious fact that the very material and human resources invested in nanotechnology research could have been used to serve other noble causes such as building much-needed public hospitals and nurseries. It means that we have to have good reasons not just for supporting nanotechnology research, but also for *prioritizing* nanotechnology research over other public development plans.

It is not clear how this extra justification or *accountability* can be obtained for national research projects including that of nanotechnology. I am not saying that it is impossible or extremely difficult to get the necessary accountability, but just pointing out that we do not have any well-defined procedure for deciding on the *relative* importance of public projects (not their potential benefits in absolute terms), which is itself justifiable in terms of democratic principles.

Perhaps Kitcher's idea of 'well-ordered science' might be one suggestion to consider in this context [8]. But for the time being, we may have no choice but to settle back with the conventional method of relegating our decisions as regards the relative evaluation of public projects to the policy-makers in our government and national assembly.

Although we may not be able to set up a better system of ascribing accountability based on democratic ideals, that shouldn't deter us from imposing on nanotechnology research currently available regulations usually reserved for the public research projects. The regulations should be understood not just in terms of well-kept financial book-keeping, but also in terms of well-maintained moral practice by the researchers involved.

II. Nanotechnology in South Korea

Nanotechnology in South Korea is typically associated with a number of nano household products especially nano-silver washing machine, although the genuine 'nano'-ness of these products has been debated, and Samsung was denied by EPA to claim the excellent performance of their washing machines allegedly based on the mysterious characteristics of silver nanoparticles [9,10]. Household nano products such as nano-silk toothpaste turned out to be unexpectedly efficient to promote a positive image into public minds partly because their familiarity in daily life made the claims of rather vague benefits of nanotechnology rather convincing, and also because the amazing efficacy of silver was embedded in Korean minds through the image of a blackened silver spoon when dipped in toxic soup, a common theme in old-fashioned period dramas.

In short, the public image of nanotechnology in South Korea is by and large positive [11]. Apart from already mentioned help from the familiarity of

household nano products, the relatively good reputation of nanotechnology in public may be the result of public recognition (and implicit acceptance) of the following loose logic. That is to say, the Korean government puts a lot of efforts and resources into the development of nanotechnology, and they do so in order to excel in the future industrial competition, and therefore it is a good thing to support nanotechnology research for the future economic growth of South Korea. Given that the public generally has little opportunity to be informed of potential, uncertain risks of nanotechnology and no particular expertise in evaluating alternative strategies to achieve economic growth, it would be rather strange if the general public take any different attitude other than being moderately positive towards nanotechnology.

The broad support of the general public for nanotechnology research (or for that matter, any frontier technology research), however, should not be understood to exclude the possibility of their unspecified anxiety [12]. For instance, the general public is easy to be sensitized to the potential health risks of massive nanoparticles in the air, for they are already familiar with the air pollution problem resulted from micro and submicro particles. Whether or not the exact mechanism of the potential problems from nano particles resembles that of micro particles, people will be rightfully concerned about if necessary and sufficient precautionary measures are taken to tackle the problem and if any irresponsible desire by the developers would compromise public safety and interests.

There is concrete evidence for the fact that the public indeed care about the potential risks of nanotechnology. There have been several exercises of technology assessment (TA) on various aspects of nanotechnology in South Korea. Under the management of KISTEP, the 2005 nanotechnology TA conducted a public survey as well as consensus conference where the general public (or more accurately, a

sample of the general public) were asked of their expectations and concerns. The 2005 TA found that people were eager to know more about nanotechnology in its benefits and risks [13]. It is reasonable to think that the survey results showed that the general public is anxious about the very aspect of 'uncertainty' of the future society which is likely to be heavily influenced by nanotechnology. It could be 'Brave New World' all again, and the only difference might be the fact that we just cannot be sure of the exact nature of the this particular 'New World' to the same vividness as Aldous Huxley envisaged in his 1932 novel [14].

In short, the moderate optimism among the general public should not be confused with their overall commitment to the unrestrained development of nanotechnology. They want more information available to them so that they can evaluate nanotechnology based on balanced and often mutually-conflicting opinions, and make their own informed-choices. The public access to all known scientific and social facts about nanotechnology in particular, and once-promising technology in general is therefore crucial for public engagement in the democratic development of nanotechnology [15].

III. Risk and Risk-Perception

One might claim that it is not justified to require researchers and policy makers to pay any attention to public opinions on the development of emerging technology such as nanotechnology. After all, the so-called public opinions are just uneducated, easily changeable public *perception* of emerging technology, not a well-informed, solid evaluation of experts. The general public by definition do not have any expertise to judge on technical matters in research policy, and therefore their decisions cannot be properly based on relevant facts. but rather on false conceptualizations

and misguided moral assumptions.

Let us consider the claim in terms of two distinct concepts: risk and risk-perception. Those who are opposed to take too seriously public perception of nanotechnology might rephrase their view in terms of these concepts. That is to say, public concerns about the potential problems of nanotechnology are often based on their merely subjective risk-perception rather than objective, scientifically meaningful risk itself.

Risk can be defined by the probability (usually understood in terms of relative frequency, actualized or estimated) of the risk-event. Risk-perception is on the other hand loosely understood how a person feels about the danger or problematic nature of the risk-event. It is well known that there is a discrepancy between risk and risk-perception [15]. Although the risk of airplane crash (defined by its relative frequency) is quite low, in fact lower than rather mundane car crash, people usually fear airplane crash much more than car crash. It may due to the dramatic aspect of airplane accidents or the dreadful fatality of the wounded. But a 'rational' person (according to the conventional definition of 'being rational' to be consistent with objective probabilities) should care for only risk, not risk-perception in his/her decision-making. Or shouldn't he/she?

Let us consider the apparently obvious contrast between risk and risk-perception. Risk-perception is variable in the sense that it is different from one person to another, and changeable in the sense that it usually becomes different even for the same person in the course of time, and prone to be polarized in the sense that it more often than not marginalizes moderate, balanced opinions especially in the earlier stage of public discussion of risk-events.

But even risk based on our best available scientific evidence is still variable in the sense that it is often different from one expert to another, depending on how non-empirical aspects of the risk-event are

dealt with in the risk analysis. One expert may include the potential 'aesthetic' damage of a well-preserved forest in the calculation of risk of a newly-built factory, and another expert may disagree insisting on considering only 'tangible' economic costs in the risk analysis.

Also the judgment of risk is trivially changeable in the sense that if we gather more scientifically relevant evidence, we may readily change our evaluation of risk in the future. Furthermore, although the good scientific standard of risk evaluation won't allow polarized verdicts, the risk evaluation actually adopted by mass media or government often presents the risk surprisingly low or high. So it is not altogether clear whether there is unbridgeable difference between risk (or more appropriately, our judgment on risk) and risk-perception in real situations to justify the clear-cut differential treatment towards them.

Not only we do have good reason to take impartial view on risk and risk-perception, we also have good, independent reason to take risk-perception seriously. Public risk-perception of nanotechnology should be taken seriously at least for following three reasons; public risk-perception is effective, objective and legitimate.

Risk-perception especially that with broad public support is effective in mobilizing people into actions which could engender the developmental future of nanotechnology if not taken seriously.

We do have a case like that, namely the social controversies over the selection of nuclear waste disposal sites. In this case, unexpected social costs had to be paid mainly because policy makers didn't anticipate the power of public risk-perception. It may well have been true that the public risk-perception in this case was misguided by exaggerated risk-claims, although that judgment itself is controversial. But it doesn't matter if public risk-perception could be unduly influenced by one opinion or risk-p. As long as it can mobilize the general public to act in a massive scale,

researchers and policy-makers should pay greater attention to public risk-perception, not least because they have obligation to reduce unnecessary social costs involved in the badly-managed following process.

Public risk-perception is objective in the sense of being intersubjective. Even granting how an individual feels about nanotechnology doesn't matter much, how the general public feel about is a totally different matter. Being shared by many individuals, the risk-perception can obtain the status of 'intersubjectivity'. Intersubjective opinions do not necessarily mean correct or true ones; if that is the case, mob democracy should rule the society. But it is undeniable that intersubjective risk-perception is worthy of being discussed and examined carefully to see first if their perception is well-founded, and secondly how we should deal with public worries in democratically satisfactory ways. One may say that the very simple fact that intersubjective risk-perception is shared by many people demands its serious treatment.

Finally, public risk-perception is legitimate in the sense that it should be legitimately taken into account by policy makers from the perspective of our democratic ideal of a good society. In an ideal democratic society, we would expect our researchers and policy makers to care about not only the well-being of citizens from their own perspectives but also from the very citizens' perspectives. The idea of autonomy of citizen, highly valued in the democratic ideal, requires that the individuals in a democratic society should be able to choose what *they* think good for them rather than be chosen for them by others what others think good for them, however, good-intentioned others are [16,17].

Autonomous individuals do not want to become like the 'savages' in the 'Brave New World' even when the measurable quality of well-being of the 'savages' is enhanced by new technology. Notice that this attitude

doesn't imply a new type of Luddite movement. The attitude has no intrinsic connections with any type of anti-science feelings. It just points out that the public risk-perception is legitimate from the autonomous individuals' point of view, and should be treated with due respects.

IV. Nanotechnology Research in a Democratic Society

I argue that risk and risk-perception is not that different from each other if we are willing to see more deeply into their actual manifestations. I also argue that there are good reasons to take seriously public risk-perception considering their effectiveness, objectivity, and legitimacy. From these arguments, I conclude that we should take a proper care of public risk-perception about nanotechnology as well as its probabilistic risk in order to secure the productive development of nanotechnology in a democratic society.

If I am right up to this point, South Korea being a democratic society cannot escape the conclusion. Moreover, we do have a few unfortunate cases in which the neglect of public risk-perception had damaged research management or technology development. The cases clearly showed us why managing public risk-perception properly is non-optional in a democratic society. One aspect of proper management of public risk-perception should include allowing relevant information about nanotechnology widely available in non-patronizing way.

The complication of proper risk-perception management can be thought as unexpected but legitimate costs to pay for living in a democratic society. One nice thing about risk-perception is that it is possible to reduce its unnecessary costs in a democratic way as long as we are prepared to accept public risk-perception as a proper part of our considerations in sci-

entific research.

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나노기술에 있어서의 위험과 위험인지

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나노기술은 현재 대부분의 연구 및 산업 선진국에서 미래의 가장 영향력 있는 기술로 간주되고 있다. 이런 이유로 여러 나라의 정부는 미래의 기술경쟁에서 앞서 나가기 위해 나노기술 연구에 상당한 인적, 물적, 자원을 투입하고 있다. 그러므로 나노기술 연구는 다른 곳에 쓰일 수도 있었을 공적자원의 사용과 관련된 책무성을 요구받는 분야가 된다. 저자는 나노기술 연구의 책무성을 적절하게 지켜내기 위해서는 위험만이 아니라 시민의 위험인지도 반드시 고려해야 한다고 주장한다. 흔히 위험인지는 객관적 확률로 주어지는 위험에 비해 사람에 따라 달라지고, 시간에 따라 변화하고 극단적으로 양분되는 경향을 보인다는 근거에서 기술연구 정책에서 정당한 고려사항이 될 수 없다고 여겨진다. 하지만 저자는 위험인지가 대중이 특정 방향으로 행동하게 만들 수 있다는 의미에서 유효하고, 많은 사람이 공유한다는 의미에서 상호주관적이며, 민주주의 사회에서 필수적으로 반영되어야 한다는 점에서 고려대상으로서의 정당성을 획득한다고 주장한다.

주제어 : 나노기술, 책무성, 위험, 위험인지, 민주사회

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