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Applying the Precautionary Principle to Nanotechnology

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Introduction

The development of molecular nanotechnology (MNT) carries numerous risks, including the production of potentially unhealthy nanoparticles, the possible creation of tiny, destructive, self-replicating robots, and many others. The Precautionary Principle is often invoked when dealing with situations that might be hazardous; however, the label "Precautionary Principle" is attached to at least two different ideas, which must be analyzed separately.

This paper discusses two forms of the Precautionary Principle, which we will call the "strict form" and the "active form", and relates them to the purpose of the Center for Responsible Nanotechnology, and to CRN's policy recommendations.

Two Forms of the Precautionary Principle

The *strict* form of the Precautionary Principle requires inaction when action might pose a risk. An example of this form is shown in the following quote from an article on regulating nanotechnology: "The principle, itself a topic of debate, was designed to reduce environmental and health risks by limiting scientific exploration when its impact is in doubt."

In contrast, the *active* form calls for choosing less risky alternatives when they are available, and for taking responsibility for potential risks. For example, Article 15 of the Rio Declaration on Environment and Development states: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." In other words, if damage is likely but not certain, the lack of absolute certainty is no excuse for failing to mitigate the damage.

The strict form of the Precautionary Principle is similar to the maxim often attributed—falsely—to the Hippocratic Oath: "First, do no harm." If action may cause harm, then inaction is preferable. In particular, if scientific investigation could lead to harm or risk, then that line of research should not be pursued. There are two problems with this guideline. First, almost any action creates a certain amount of risk, and this is especially true of research that seeks to answer unsolved questions. Strict adherence to this guideline would prevent virtually all scientific endeavors. Second, inaction carries its own risks, which may be greater than the risks of action. By its bias toward inaction, the strict version can create increased risk. A scientific endeavor with great potential for mitigating one risk, and small potential for creating another, would be forbidden by the strict version.

This reading is not merely the result of journalistic carelessness. Some policy advocates have followed this course. For example, in an article recommending the application of the Precautionary Principle to genetically modified crops, Dr. Mae Wan Ho writes: "It is up to the perpetrators to prove that the technology is safe beyond reasonable doubt."

The active form of the Precautionary Principle urges more action instead of less. When a potential risk is identified, the appropriate response is to search for less risky alternatives, and use them instead if practical. *The Precautionary Principle In Action: A Handbook*[5] lists five components of a precautionary approach:

Taking precautionary action before scientific certainty of cause and effect

Setting goals

Seeking out and evaluating alternatives

Shifting burdens of proof

Developing more democratic and thorough decision-making criteria and methods

The active form does not automatically forbid risky activities; instead, it calls for an appropriate effort to mitigate the risk—which may well involve finding and choosing a different activity.

Applying the Precautionary Principle to Nanotechnology

Molecular nanotechnology is currently the subject of much scientific uncertainty. Several prominent scientists have gone on record with the opinion that self-replicating nanotech machines are impossible, or at least sufficiently difficult that they will never be built.[6] On the other hand, some scientists believe that such a thing is quite feasible.[7] The question is

important, because a self-replicating machine could in theory get out of control and make too many copies of itself; if a complete self-contained, foraging, self-replicating system were too small to be easily recaptured, it could do serious damage to the environment.

The risk of biology-eating "gray goo" arising from MNT research has been recognized for over a decade.[8] At this point, science does not have sufficient information to rule on the likelihood or even the theoretical possibility of such a risk. This is the sort of case that the Precautionary Principle was designed for: "The litmus test for knowing when to apply the precautionary principle is the combination of threat of harm and scientific uncertainty."[9] The strict form would clearly prohibit research that might lead to gray goo. However, the active form of the Precautionary Principle might give a very different answer.

The Center for Responsible Nanotechnology recognizes the possibility of gray goo, along with dangerous arms races and widespread use of destructive products, if MNT fabrication capability is ever developed. CRN is dedicated to reducing these risks as far as possible. However, we do not believe that it will be feasible to enforce a permanent, global prohibition of MNT. Nuclear non-proliferation has been more or less successful, but the fact remains that many nations have gained a nuclear capability in the last half-century.

MNT fabrication will be based on technologies that are being developed for many legitimate reasons. Within at most a few decades, the ability to manipulate complex molecules in complex ways will be common in a variety of fields, including biology, electronics, materials science and medicine. Rapid prototyping and automated assembly are already being used commercially. On a darker note, the military potential will ensure that nations do not risk letting other nations develop nano-fabrication first. Although it may be possible to delay the development of MNT fabrication, sooner or later the world will have to deal with the results of a successful nanofabricator project.

The fact that MNT also promises many benefits is important for at least two reasons. First, the promised benefits will encourage the development of the technology, making it more difficult to enact—and enforce—prohibitions. Second, some of the promised benefits may alleviate serious and global problems, and this must be included in any assessment of possible courses of action. For example, nanotech-based manufacturing could produce much less pollution than traditional methods. Nanotech products could use mechanical means to do what is done today by a variety of dangerous chemicals. Cheap local manufacturing will reduce the transportation of goods, and may save land and water by allowing more efficient farming. Today many nations, both rich and poor, live unsustainably; development of advanced nanotech may provide solutions for diverse and serious environmental problems.

Our Position

Because the *strict* form of the Precautionary Principle does not allow consideration of the risks of inaction, CRN believes that it is not appropriate as a test of MNT policy. Inaction poses at least three severe risks:

1. No other solution may be found for certain pressing problems.

2. Inaction on the part of responsible people could simply lead to the development and use of MNT by less responsible people.

3. Lack of understanding of the technology will leave the world ill-equipped to deal with irresponsible use.

The *active* form of the Precautionary Principle, however, seems quite appropriate as a guide for developing MNT policy. Given the extreme risks presented by misuse of nanotech, it appears imperative to find and implement the least risky plan that is realistically feasible.

CRN has identified several sources of risk from MNT, including arms races, gray goo, societal upheaval, independent development, and programs of nanotech prohibition that would require violation of human rights. It appears that the safest option is the creation of one—*and only one*—molecular nanotechnology program, and the widespread but restricted use of the resulting manufacturing capability. This opinion, and the reasoning behind it, is explained in our other papers. If a safer possibility is suggested, and appears to be workable, CRN will publicize that possibility; if a fundamental flaw is found in our current proposal, we will publicly retract it.

CRN promotes the responsible development of MNT—not because we believe it is *safe*, but because we believe it is *risky*—and the only realistic alternative to responsible development is irresponsible development. Although we cannot agree with the strict form of the Precautionary Principle, we support the active form, and we request feedback from all readers to improve our understanding of how to further minimize the risks inherent in this powerful new technology.

References

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[3] http://www.geocities.com/everwild7/noharm.html

[4] http://www.biotech-info.net/PP_coherent.html

[5] http://www.biotech-info.net/handbook.pdf

[6] See, for example, George M. Whitesides, "The Once and Future Nanomachine", *Scientific American* 285 (September 2001), pages78-83

[7] http://www.imm.org/SciAmDebate2/whitesides.html#ref001

[8] One of the earliest discussions was by K. Eric Drexler, *Engines of Creation,* Anchor Press, 1986.

[9] http://www.biotech-info.net/handbook.pdf (see section II, page 3)