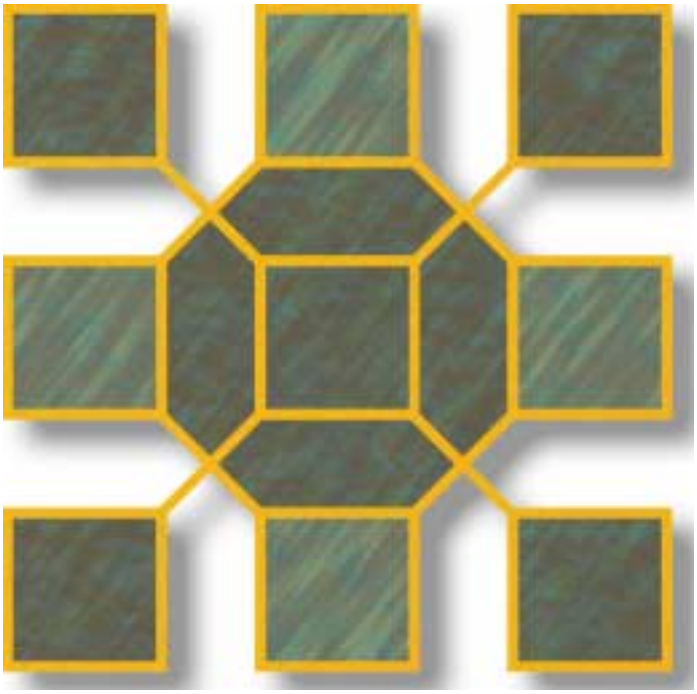

Nanotechnology:

Losing the Revolution

Eudoxa Policy Study #3

Eudoxa Policy Study #3: Nanotechnology: Losing the Revolution

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This series of policy studies are published by The Eudoxa Think Tank. They address issues that are current or will be in the near future. Eudoxa Studies are in depth studies on how emerging technologies impact our culture and our society.

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ISSN 1652-0726

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About Eudoxa

The Eudoxa Think Tank is a think tank based in Stockholm, Sweden. The main focus of the group is explaining the cultural impact of emerging technologies integrating the analysis with classical free-market ideas and dynamist thoughts of experimentation, innovation and decentralization.

We work for a diverse society based on a strong moral foundation of individual rights, where individuals have the right to utilize modern technology and medicine according to their own moral judgement. We belive this foundation promotes tolerance and acceptance that will tie our society together, not break it apart. The inspirations behind our vision are a firm belief in individual libety, free enterprise, a limited government and that ideas have impact on our society.

Eudoxa currently has staff working out of Stockholm, Sweden and Kansas City, Missouri, giving them the advantage of being able to approach both the European and American market with a comprehensive perspective drawn from experiences from both contintents.

Executive Summary

Nanotechnology, manufacturing on the molecular and atomic scale is a promising new technology is being attacked before we even know that it is feasible. Opponents of development are misusing the precautionary principle to demand regulations and stifle development. The Canadian public policy group ETC is demanding international moratoriums on the research and UN regulations of new technologies. This study shows why we can loose the revolution before it even began.

Nanotechnology: Losing the Revolution

Nanotechnology, the manufacture of materials and machines with atomic precision and size, is widely regarded as the next revolution in technology. While the debate rages on its eventual capabilities or even how to define it, it is becoming popular for funding and investment. But also a target for environmentalist attack despite being still largely theoretical. Is this because it represents an unprecedented threat, or because it is the next step in human control over the environment? And will unfounded fears today paradoxically cause regulations that open far greater risks in the future?

While the possibility of disaster stemming from nanotechnology has been discussed in science fiction and among nanotechnologists for years, the first major public campaign on nanotechnology and safety originated with the Winnipeg based organization ETC Group. Over the last years it has worked hard to bring up the issues of nanotechnology internationally, gaining a favorable reception among many NGOs. Pat Mooney, the group's executive director, claims he is not against nanotechnology per se and believes that it has a huge potential for improving health and the environment. His worry is that the science is unregulated and must be brought under control in the near future in order to prevent human harm or undesirable social consequences.

K. Eric Drexler coined the word nanotechnology in the mid 80's as he was considering the possibilities of molecular manufacturing. The idea that technology would eventually be miniaturized to molecular and atomic level was older (Nobel laureate Richard P. Feynman suggested it in a talk 1959) but Drexler began to consider the implications. He realized that the consequences were staggering: not just atomically perfect materials, but by assembling atoms as building blocks nearly anything could be constructed with a minimum of waste and pollution, making matter essentially recyclable and as reconfigurable as software. Molecular computers and robotics would enable entirely new possibilities in nearly all areas of life. He set out to demonstrate how these "wild" ideas were feasible within known laws of physics and to promote nanotechnology.

In the early and middle 90's nanotechnology were just speculative ideas, something to interest open-minded researchers, engineering hobbyists and science fiction fans. Despite attempts to show the validity of the concept it was largely ridiculed in Scientific American 1996. But slowly the idea percolated through the scientific community. It went from a wild idea to a radical idea to the next big thing. Suddenly funding for nanotechnology research appeared and it was not just acceptable to study it but a good buzzword to add to the research proposal. But in becoming acceptable research the original meaning of nanotechnology had been diluted. Whereas Drexler was considering operations on the molecular scale using molecular tools, nanotechnology now appears to

mean any technology involving extremely small structures. One reason is of course that as it became well funded it was advantageous for researchers to call their research nanotechnology if it involved tiny structures in some way.

Unlike Bill Joy, who in his widely debated article "Why the Future Doesn't Need Us" in Wired warned against science fiction-like dangers such as self-replicating machines, superhuman artificial intelligence and changes to the human condition (also a worry of Francis Fukuyama in his Our Posthuman Future) Mooney instead focuses on nanoparticles. Pieces of nanomachines or materials on the order of a billionth of a meter in size might exhibit unexpected danger, he warns. Just as ordinary silica can cause deadly silicosis if small particles are lodged in the lungs it is not unreasonable to think that nanoparticles could cause grief.

This is a wise choice of target, since it is far easier to get regulators worried about something similar to past troubles than an entirely new range of possibilities. It is also internationally far easier to get across; while the grand possibilities of nanotechnology in the US are seen as at least potentially relevant, in Europe the perspective is far more feet in the ground and directed towards practical applications in the very near future. It also fits the perspective of most researchers working in the field, as they are not just more familiar with issues of dust and chemistry but also unwilling to engage in "wild speculation". There is a strong concern within any developing field to keep it serious and avoid being branded as lunatic fringe.

At the same time hype is a temptation: claiming one's work to be revolutionary is a good way of getting funding. But there are acceptable forms of being revolutionary (claiming vastly enhanced industrial outputs) and there are too wild forms of revolutionary (entirely new possibilities, such as human enhancement).

The problem may be that in looking at the here-and-now issues we lose sight of the larger and more important issues facing us. Nanoparticles might be troublesome, but it is unlikely to be a showstopper for nanotechnology. Problems can likely be designed away with some forethought. But even fairly mild nanotechnology raises important issues of what we want to achieve with industry and our lives, where we want to take the economy and our species. These are the real issues, but they cannot be debated within the rather narrow discourse among regulators and engineers.

The main claim of ETC is that the biological and ecological effects of nanoparticles are unresearched and unknown. On one level this is true: we do not know everything about nanoparticles, something that all researchers in the field agree should be remedied (no

researcher has ever turned down funding for further research in his area). On another level it is not true: we already have much information about the biological effects of nanoparticles, and that may be used to suggest proper policies as we wait for further information. Robert Freitas Jr's Nanomedicine, a vast review of nearly everything relating to nanomedicine, devotes the entire second volume to the issue of making nanomachines compatible with living tissues. While the reviews conclude with the need for more research, the interim judgment appears positive: most nanoparticles studied so far do not exhibit any toxic effects, and the risks of random nanoparticles are likely low.

A skeptic would remark that we need to apply the precautionary principle: just because we have no evidence so far that the products of nanotechnology would be risky does not mean they will not do so in the future, and hence a moratorium is proper until the right safeguards have been found.

But before one should try banning something one has to have a reasonable expectation that it could be dangerous. The precautionary principle does not say that lack of scientific evidence for safety is a reason to ban, rather that we should be careful even when risks are uncertain. Most exotic fruits sold in stores have never been tested as health hazards despite being new and unknown to the customer. The knowledge that other people have eaten similar fruits in the past is no proof that it would be safe for Canadians but it makes it likely that they are safe. On the other hand, if a certain kind of fruit were closely related to a toxic or narcotic species, then it would be proper to examine it closely.

The precautionary principle is often misused as a tool to stifle development or gain political control over it rather than the common sense approach of being careful with things that we have reason to suspect are dangerous. The real test of sincerity in applying it is whether the one proposing it is interested in examining benefits in addition to risks, and weigh them. Quite often potential benefits clearly outweigh even fairly clear risks, as in vaccinations, and precautions should be applied in such a way that they do not stifle beneficial development. But when the risks are automatically given primacy, then there is no room for constructive analysis – other issues than just risks are the real source of the controversy.

ETC has in its reports proposed a shutdown of all research and development of molecular manufacturing and a moratorium on commercial production of new nanomaterials. They have also called for the creation of an international forum for examining new technologies, UN oversight over new technologies and their marketing and an international convention for evaluating new technologies for scientific, social and

economic effects before they are loosened into society. In fact, it is a proposal nearly identical with the one suggested by Bill Joy to prevent far more dramatic dangers.

The main problem is that ETC dilutes the concept nanotechnology even further. Anything from cosmetics with nanoparticles to speculative molecular machines is viewed as nanotechnology, and supposedly just as risky. A wide range of current processes produces Nanoparticles, including the burning of diesel fuels (a case that indeed has real health concerns); should a moratorium be placed on them until they can be proven safe? By promoting the most dramatic promises and threats of nanotechnology while at the same time extending the term to cover even standard processes ETC makes it look like potentially devastating risks are being ignored.

In fact, many of the concerns are already being addressed by nanotechnology organizations such as the US NNI and through similar efforts around the world. They are not being ignored but rather treated with the customary review. But it is not hard to make this look like the authorities are not doing anything since few in the public follow scientific publications and internal reports.

The ETC group also coined the term Atomtechnology to denote the entire spectrum of technologies that manipulate molecules, atoms and subatomic particles, as well as manipulation of living and nonliving matter to create new or hybrid organisms/devices. This deliberate linking of nanotechnology with biotechnology, chemistry and nuclear technology into a single vast field seems more likely to be a strategy to make people uneasy about one of them uneasy about the rest than an attempt to show a commonality.

Overall the ETC reports often quote a vast number of authoritative sources within the fields being criticized, but often take the information out of context and add conclusions that do not follow from the full text.

For ETC nanocontamination is a means to an end. While the concern of nanodust may be real, it is also a step in the line of getting the technology “under control”. Mooney writes: "Extreme care should be taken that, unlike with biotech; society does not lose control of this technology". It is interesting to note that there are few technologies surrounded with more stringent rules and oversight organizations as biotechnology (the one that comes to mind is nuclear technology) – is this a technology out of control? To many people even a highly regulated technology may be outside of control simply by existing or being used. Biotechnology is felt by many to be abhorrent from a moral or aesthetic standpoint, or part of a system that is in itself undesirable. ETC has strong ties to anti-GMO organizations and has itself much experience in criticizing biotechnology.

It is from this context of being against the technology itself and the system it is assumed to represent that the criticism comes. By pointing out safety concerns far in advance of any truly radical applications they hope to bring in a restrictive regulatory regime – and as restrictive regulations often do, slow development.

The real risk is that we may lose the benefits of the nanotechnology revolution while trying to prevent the risks, and end up with only the risks. In slowing down development of nanotechnology many environmental benefits may be lost. One example is the use of nanocrystals for coloring. Semiconductor nanocrystals can be made to emit light of desired colors, which shows great promise in many applications. It is not unreasonable that suitable nanocrystals could replace a wide range of colorants that have toxic properties. Toxicity is a bug that can be designed away in nanotechnology, while it is merely a fact of life in current chemistry. Since many colorants can be replaced with the same nanocrystaline material there is just one material to examine for toxicity.

The law of unintended consequences is powerful when technology is concerned, but even more so in regulation. When genetic engineering began to develop in the 70's there was much fear both inside and outside the research community that genetically modified organisms could escape the lab, spread and cause disaster. As a response the research community instituted fairly strict safety regulations – not because they knew they were needed, but because they didn't know how much they were needed. As time went on and evidence accumulated they reduced these regulations to fit the emerging facts. From a scientific standpoint this was only proper, but it failed culturally. In the meantime respect and trust of researchers had declined and when they (together with the regulators) now deregulated themselves it looked less like adapting to facts and more like ignoring public concerns in the search for more research and industrial funding. It seems likely that moratoria on nanotechnology will have similar effects, but more severe: today nanotechnology is on such an early stage that a moratorium would halt nearly all research, including research on risks. And were it to be lifted, many would no doubt see it as a signal of approaching danger rather than the resolution of risk.

Add to this the failure of biotechnology in meeting public concerns by involving itself in the ethical debate. One of the most recurring strategic mistakes of the biotechnology business has been to not deal with concerns about the ethics and meaning of biotechnology. Such concerns has been viewed as unscientific, "soft" and best left to professional ethicists – despite that the researchers and industrialists personally often show great conviction in what they are doing and why. But the private vision and the public "objective" face are still often viewed as incompatible. This in turn gives opponents a walk-over victory on the ethical side of the debate, the side which many people actually consider more important than the practical aspects – jobs, health, money,

progress – that are commonly used to promote biotechnology. Nanotechnology may not be as intrinsically controversial as biotechnology, but the ethical discussion is still necessary to motivate people to (critically) embrace the technology.

There is a danger in both too little regulation and too much. Too little regulation may make investors uncertain and forestall research, beside the risk of widely publicized disasters that make consumers leery of the technology. Too much regulation may promote black market research and the move of researchers to less scrupulous offshore locations, accelerating undesirable consequences. The construction of new laws to deal with new technologies often produces either irrelevant or overly restrictive rules. And regulation has many costs, including the creation of self-perpetuating agencies that thrive on demonstrating how necessary they are.

New technologies are in general safer than old technologies, but often subjected to more stringent regulation simply because they are new. The expensive regulations remain long after they are found to be unnecessary. The result is often the perpetuation of riskier (but politically more powerful) industries at the expense of safer new technologies that do not have a built up base of political support.

Nanotechnology will undoubtedly reveal new problems and new solutions not thought out in advance. Excessively detailed regulations developed before the technology are more likely to prove a straightjacket and may actually increase the overall risk by focusing security on areas believed to be risks rather than the areas where the risks actually turn up. We will need a well-stocked intellectual arsenal to deal with unexpected problems. Pointing out obvious problems is useful, because sometimes they are overlooked at early stages while they are still easy to design away. But

If the goal is rather to hinder development than to help it become the best development possible then it is mostly a distraction from real issues and does not contribute to safety.

In the long term nanotechnology is the likely answer to many of the problems it creates. Computers can be cracked, and hence we develop computer security. The best protection against bioweapons and emerging diseases is widespread biotechnology. If escaped nanoproducts are risky or accumulate, then nanomethods are likely far better than anything else to pick them up and neutralize them.

It is the potential lack of control over nanotechnology that worries its critics. The vision is technology out of control – active devices working on their own, or industry with no oversight. But while experts have good reasons to be calm about the "grey goo" problem or many worries about nanocontamination, that will not calm the public. How are we to

trust a researcher who says extensive research has shown something to be safe? The only way to be sure is to become an expert oneself, or find trusted experts. But how do we find trusted experts in this cynical era? Watchdogs like ETC benefit from making people concerned, while a nanotechnology researcher might presumably downplay risks.

Here we come full circle to Drexler's vision again. Rather than announce that utopia was around the corner he spent much thought about the risks of nanotechnology development and how to minimize them. His suggestion was to develop technologies of foresight at the same time: social or digital tools to further knowledge exchange, constructive debate, cross-examination of evidence and views, institutions to engage the public and special interests in dialogue about potential future technologies and their risks and benefits. He founded the Foresight Institute, a non-profit organization aiming at improving policy decisions just by pursuing these goals in respect to nanotechnology and other emerging technologies. Over the years it has played an important part in shaping the molecular nanotechnology community and in suggesting safety measures (such as their guidelines on working with self-replicating machines).

The irony is that the rest of the nanotechnology field, in its eagerness to distance itself from its roots in "science fiction" it has also ignored this part of the nanotechnology vision. A shortsighted search for directly applicable practical results becomes pure science or technology, and easily misses the important policy dimensions. But opponents to technology only care about policy. If one can meet them in a policy discussion, guided by a vision more long-range than funding for the next year or a better insulin pump, then the future has a chance. Otherwise the revolution may be lost for both sides.