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Public row over princely cautions exposes nanotech's not-so-small problem – *green goo*:

Nanotech and the Precautionary Prince

Tiny tech's biggest woe may be anger management.

Prince Charles' concerns about the emerging revolution in nanotechnology (what ETC group prefers to call Atomtechnology) have catapulted tabloid headlines about "*grey goo*" (and impending doom) onto front pages around the world.[1] Industry fears that the great GMO (genetically modified organisms) debate is about to go down to the nanoscale inhabited by atoms and molecules. Despite being one of the world's best-funded new technologies, nanotech is still little known or understood outside scientific and business circles – and even less regulated by governments. While grey goo makes great headlines, many are probably still scratching their own grey goo wondering what the fuss is about.

The Precautionary Prince: According to news reports, Prince Charles' concerns stem in part from his reading of *The Big Down*, an ETC Group report on nanoscale technologies (see www.etcgroup.org for the full text and related studies). Only four pages of the 80-page study discuss the prospect of molecular manufacturing (which, if possible and allowed out of control, could lead to the *grey goo* scenario). Jim Thomas of the ETC Group's UK office explains, "Although Prince Charles hasn't talked with us, he did order several copies of *The Big Down.* It seems reasonable to assume that he is aware of the full range of issues addressed in the study. These include the health and environmental implications of nanoparticle manufacture, the implications for national economies and employment, the potential for technology monopolies as well as the future of molecular self-assembly. In fact, these are the same issues we will be discussing at a seminar in the European Parliament in Brussels on June 11th 2003 [see box below]." In so doing, the Prince is simply observing the precautionary approach for environmental safety that has been recognised by governments through the United Nations. News of the Prince's interest has galvanized industry (and some scientists) to try to marginalise St. James' Palace by arguing that the Prince's concerns are either non-existent, centuries distant, or exist only in pulp fiction. But the virulent attacks against the Prince may only be the latest of a series of technical and tactical mistakes made by nanotech's over-eager proponents.

The first mistake: Prince Charles has grounds for caution**.** Despite a quarter-century of lab work on nanoparticles, scientists worldwide have failed to establish agreed laboratory protocols to safeguard workers. Moreover, governments have allowed nanoparticles into consumer products in the absence of regulatory mechanisms. Particles that have been approved for consumer use at the micro or macro scale have not been re-tested when introduced into the same products at the nanoscale. Indeed, some nano companies pooh-poohed the notion that nanoparticles need to be evaluated for their health and environmental impact – even though the quantum characteristics of elements in the Periodic Table change radically and nanoparticles can run undetected past

immune systems and can even slip through the blood-brain barrier. Over the past year, ETC Group has brought forward a series of reports showing that real risks exist. (See, for example, "No Small Matter" and "Size Matters," www.etcgroup.org.) Partly because of this research, a growing number of scientists are acknowledging that nanoparticles could pose significant risks for the environment and human health.

The second mistake: In an ill-conceived campaign to paint critics – and now Prince Charles – as paranoid, industry has implied that concerns about nanotech come from either Luddites or science fiction fans who believe it is possible for scientists to construct nanoscale robots (nanobots). Such nanobots would self-replicate and be capable of atom-by-atom construction of everything from a Big Mac to a Mac Apple to the Big Apple. "The image is a fanciful combination of invisible sci-fi robots stacking atoms mixed with *the* Sorcerer's Apprentice," says Jim Thomas in Oxford. "This is hardly what we mean by molecular self-assembly."

Green goo: "It's not *grey goo* but *green goo* that makes molecular self-assembly worthy of serious study and plausible in the not-too-distant-future," says Pat Mooney, ETC Group's Executive Director. "Molecular self-assembly is what living materials do best. You don't need tiny tin robots. Science is merging biotechnology and nanotechnology into nanobiotechnology in order to fashion unique amino acids, proteins, molecules and cells. These will be organized in new manufacturing processes that could replace conventional machines and workers." ETC Group believes that rapid developments in this field warrant concern.

Life matters: Through the nanoscale manipulation of biological materials it is now possible (or scientists believe it soon will be possible) to:

- Craft synthetic DNA from the blueprint provided by a natural organism;
- Use the synthetic DNA to create unique living organisms;[2]
- Construct new artificial amino acids that can be built into unique proteins;
- Add a fifth letter to DNA (A, C, T, G and now "F") thus increasing the potential diversity (or destructiveness) of life.[3]
- "Write" DNA code in much the same way programmers write software;[4]
- Use DNA to build nano machines capable of exponential self-assembly;
- Design exponentially self-assembling nanomachines that can become motors, pistons, tweezers, etc. in manufacturing processes.

Time matters: While the prospects for molecular self-assembly as a major manufacturing process remain hypothetical, it would be a dangerous mistake to consider it unlikely or far-off. "Consider how the pace of scientific progress is already impacting nanobiotechnology," Pat Mooney suggests. "In 1996, after ten years, 1,000 scientists decoded the yeast genome. This year, a SARS genome was decoded in eight days. At the outset of the Human Genome Project, it took two months to sequence 150 nucleotides. Now we can sequence 11 million nucleotides in a few hours," said Mooney. "In the last ten years," Jim Thomas points out, "the number of screened drug candidates has increased by three orders of magnitude from 500,000 compounds to 1.5 billion."

Anger management: As funding and research in nanotech have grown dramatically in recent years, its proponents have been warning one another that they dare not make the same mistakes the agbiotech companies made when GM crops were introduced in the mid-1990s. Yet, when critics of nanotech pointed out that industry had introduced nanoscale particles into consumer products without adequate testing for health and environmental impacts, the industry resorted to diversionary tactics. The recent attacks on the Prince of Wales by nanotech proponents are reminiscent of the worst blunders of biotech's boosters. By characterizing all legitimate concerns

as hysterical and *grey goo*-related, industry is desperately seeking to silence all voices of caution. In doing so, they risk making ever larger mistakes.

Seminar in European Parliament: Together with The European Greens, *The Ecologist*, Greenpeace, the Dag Hammarskjöld Foundation, Genewatch UK, Clean Production Action and a cross-party group of MEPs, ETC Group will hold a seminar on nanotechnology in the European Parliament in Brussels on June 11th 2003. Led by international experts, the seminar will look at both the issues related to nanoparticle safety and the potential for molecular self-assembly with a view to consider appropriate steps for societal discourse and government regulation. Speakers include physicist Dr. Vandana Shiva and toxicologist Dr. Vyvyan Howard. The seminar will be followed, on June 12th by a discussion among civil society organizations in Europe on strategies to address the issues involved in nanotechnology. For further information please see ETC Group's website, www.etcgroup.org.

[1] Jonathan Oliver, "Charles: 'Grey Goo' Threat To the World," *The Mail on Sunday*, April 27, 2003, p1. For responses, see: Japer Gerard, "Charles gets in a wee tizz over nanotechnology," *Sunday Times* (London), April 27, 2003 and Anon., "MP's anti-science slur on the Prince," *Norwich Evening News*, April 28, 2003.

[2] Alexander Goho, "Life Made to Order," *Technology Review*, April 2003. Available on the Internet: www.technnologyreview.com

[3] *Ibid.*

[4] *Ibid.*

ETC Group will release a new Communiqué related to this subject in May, 2003.