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Slaying myth about unsafe qqqagrey goo' nanotechnology

Nanotechnology is developing at an astonishing rate, with an increasing number of products coming to market that take advantage of modified material properties. Nevertheless, concerns persist over the risks associated with nanotechnology.For many journalists in the popular press and, therefore, members of the public, the main threat comes from self-replicating biological nanomachines widely referred to as agrey goo'. Eric Drexler, who has been called the afather of nanotechnology', first wrote about grey goo in his book Engines of Creation, published in 1986, though Richard Freyman pointed out as early as 1959 that nanometre-scale machines could be built and operated. Drexler wrote that, with the precision inherent in molecular construction, it would be easy to build multiple identical copies, which raises the possibility of exponential manufacturing, in which production systems could rapidly increase their productive capacity and, ultimately, lead to destructive runaway self-replication. In June 2004, however, Drexler, together with Chris Phoenix, published a paper1 that largely dismissed the threat posed by grey goo. This paper explains that self-replicating machines are still possible, but not with current technology. Moreover, self-replicating machines are denounced as unnecessary, requiring additional complexity and cost compared with more efficient nanofactories that can produce nanodevices using production line principles (Fig.1). The authors therefore state that the construction of anything resembling a dangerous self-replicating nanomachine can and should be prohibited (though prohibition cannot prevent development by determined, unscrupulous individuals, organisations or states).However, having slayed the grey goo myth, Phoenix and Drexler go on to draw attention to other areas of concern. In particular, a convenient manufacturing capacity could be used to make powerful -- albeit non-replicating -- weapons in vast quantities, leading to an arms race, war, terrorism or oppression. Although such manufacturing equipment could potentially be compact due to the nature of the raw materials and the products, a large number of such nanofactories would be required to produce macroscopic quantities; a single molecular fabricator working at one million cycles per second would take around one year to generate one nanogramme of product.Other potential problems relating to nanotechnology highlighted by Phoenix and Drexler include radical shifts in economic and political power, and aggregate environmental risks from novel products and large-scale production.Top-level concernsConcerns about nanotechnology have been raised at all levels. In the UK, the Prince of Wales has spoken about his fears, and the UK government was moved to commission a study in June 2003, the report of which was published at the end of July 2004.Nanoscience and nanotechnologies: opportunities and uncertainties was prepared by the Royal Society and the Royal Academy of Engineering and is available via a website created specifically for the study (www.nanotec.org.uk). This is probably one of the most thorough independent studies into nanotechnology and, most importantly for this fast-moving field, one of the most up-to-date. A substantial amount of the report covers the wide-ranging applications and benefits offered by nanotechnology, but it also looks in detail at the associated risks.While self-replicating grey goo has been the biggest fear for many people, the truth is that there are other more pressing concerns. For example, toxicologists have reported examples of particles being inhaled, absorbed into the blood and then being transported to the brain. Although no adverse reactions have been seen, it is possible that nanoparticles may be developed in the future that do have adverse affects. Similarly, nanoparticles are already been commonly used within sunscreen products and it is not yet known for certain whether these may be absorbed through the skin and go on to cause problems -- especially if the skin has been damaged, perhaps through sunburn or eczema. The fact is there are still some unknowns, and the opportunities and uncertainties report stresses that data needs to be collected over the long-term to enable the situation to be monitored.Inhalation and absorption through the skin are possible for nanoparticles and nanotubes that exist in a free form, and particular care needs to be taken in production environments where concentrations might be greater. And there is also a greater risk of explosion if dust clouds of combustible materials form, especially considering the larger ratio of surface area to volume, compared with bulk materials.Because of the additional risks to human health and the environment posed by materials when they are present as nanoparticles or nanotubes rather than in their bulk condition, one of the report's recommendations is that materials in these forms should be classified and treated differently.But it is expected that most applications for nanotechnology will make use of nanoparticles as coatings or fixed within bulk materials. When firmly attached in this way, nanoparticles and nanotubes clearly present a much reduced risk, though the report warns that the product's complete lifecycle, including disposal, needs to be considered carefully, especially in view of the unknown way in which nanoparticles and nanotubes will persist in the environment and bioaccumulate.Nanotechnology certainly offers huge benefits but with some unquantified and unknown risks, so the best approach seems to be to proceed with development and for researchers, manufacturers and regulators to take sensible measures to manage the risks.Source: Engineer Live!

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