Nanotechnology – the debate

all direct quotes from: ***The Social and Economic Challenges of Nanotechnology,*** ISBN 0-86226-294-1. Economic & Social Research Council of UK government

one end: clear-cut revolutionary, radical discontinuity from current developments – focus on the theoretical possible – long term potential, kind of as long as there is no law of nature forbidding it, it will be done, problem not all laws of nature are yet known

REALITY possibly in between

other extreme: there is not much to it, things go smoothly, evolutionary,

radial discontinuity: Drexlerians, Foresight Institute (Chairman Drexler)

Drexler K.E. (theoretical physicist), MIT PhD thesis, popular science book: Engines of Creation 1986

self replicating nanobots "assembles that will let us place atoms in almost any reasonable arrangement … will let us build almost anything the laws of nature allow to exist …

"nanorobots are envisioned that could destroy viruses and cancer cells, and repair damaged structures"

"materials' properties and devices performance will be greatly improved"

J. Dinkelacker science writer, transition to tomorrow (2002)
Foresight Institute advisory board

Molecular Epoch ! involves major social changes founded on

“total (or near total) control over the structure of matter”,

“novel materials and capabilities, leading to novel living patterns, new ways of socializing, and yielding fresh approach to cooperation and competition …. stunningly new materials, … fabulously enhanced health, and a profusion of marvelous benefits”

nanotech offers potential for global material abundance, it is the loss of scarcity that has the “potential for dramatic social change”

Bill Joy, 2000, chief scientist Sun Microsystems “Why the future doesn’t need us” in “Wired”

“replicating and evolving processes that have been confined to the natural world are about to become realms of human endeavor”

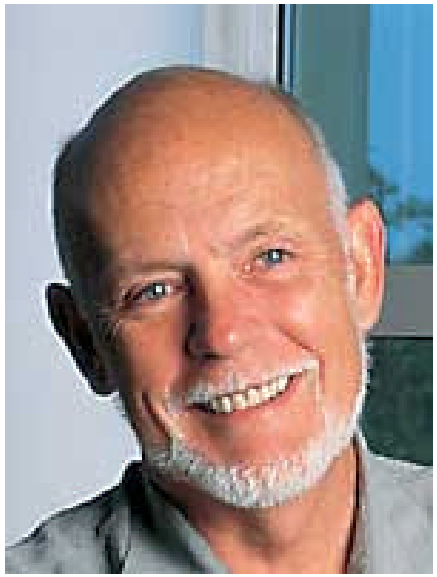
G.H. Reynolds, Forward to the Future: Nanotechnology and regulatory policy (2002) Law professor, legislation is needed

Mark Suchman, sociology Prof., EC-NSF Workshop 2002

distinguishes between “nanates” = new materials and “nanites” = Drexlerian nanobots

Cautious evolutionists

Richard E. Smally, Nobel prize for co-discovery of fullerenes in 1996



“On Chemistry, Love and Nanobots” Scientific American 2001

chemistry is the most effective method of molecular manipulation as atoms perform a “complex dance involving motion in multiple dimensions” in chemical reactions

nanobots and assemblers ***“are simply not possible in our world”***

Smalley: “fat fingers problem”

need to control all atoms surrounding the reaction site would require so many manipulators that there would be no room,

Smalley: “sticky fingers problem”

the atoms forming the nanobot would themselves bound with the atoms to be manipulated

that's close to fundamental quantum mechanics,

$\Delta x \, \Delta p_x = {}^{h}/_{2p}$ W. Heisenberg, Nobel prize physics 1932

you can't determine which slit a photon, electron, (elephant) went trough in a Young's double-slit experiment without destroying the interference pattern at the same time R. P. Feynman, Nobel prize physics 1965

George M Whitesides, real nanotechnology pioneer, surface chemist

nanotechnolgy can learn much from biology, "nanoscale machines already do exist in the form of the functional molecular components of living cells"

since these machines are a product of evolution rather than man-made design, the challenge nanotechnology faces is trying to mimic these machines in synthesized analogous, it would be “a staggering accomplishment to mimic the simplest living cell”

what man did for the past 50 years semiconductor transition was scaling down, but

*“biology and chemistry, **not a mechanical engineering textbook** ” may hold solutions for nanotechnology”*

***Philip Ball,** freelance science writer, consultant editor of Nature,*

macroscale engineering has had little need so far to learn from nature, the fact that the nanoscale is shared with cells, viruses and bacteria makes biomimicry imperative

“either we embrace chemistry of resign ourselves to perpetually swimming upstream”

Drexler’s ideas of nanorobots and “submaries” in the blood stream are to Ball obvious nonsense

“the literal down-sizing of mechanical engineering … fails to acknowledge that there may be better, more inventive ways of engineering at this scale”

in most cases it will be easier and better to use nature's machinery directly rather than attempt to emulate it: "learning from nature becomes a matter of adapting nature's existing machinery for technological ends"

In summary: Smalley, Whitehead and Ball argue that Drexlerian vision of molecular manufacturing is feasible – that conception of nanotechnology either does not fit within the laws of physics and chemistry as they operate on the nanoscale or is redundant due to superior power of biological processes

some more clarification – non scientific :

nanotechnology is nothing but an umbrella, comprising three elements: science, engineering and technology at the nanometer scale

what's created may be called: nanoartefact, the key to its production is systems integration, materials science and engineering, mesoscopic physics, full quantum physics, chemistry, biology, …, new forms of mechanical engineering, ….

Gary Stix: Little Big Science in Scientific American: nanotechnology is

"***long on vision and short on specifics"*** **-** *"the science establishment itself is a little unclear about what it means when it invokes nano"*

when the scientist are non specific, the charlatans take on the education of the public

Utopian visions, the friendly ones

Drexler in Engines of Creation: "*Assemblers will be able to make virtually anything form common materials without labor, replacing smoking factories with systems as clean as forests … They will indeed be engines of abundance"*

with bottom up approach: replicating nanobots will *"copy themselves by the ton, then make other products such as computers, rockets engines, chairs, and so forth"*

his board of Foresight Institute fellow **Dinkelacker:**

"manufacturing may become local" with the introduction of "a general household appliance, about the size of a microwave over, that can make may diverse products according to programmed instructions"

total control over matter at the atomic level that nanotechnology somehow? suggests? "entirely new devices and products, better medicine and healthier foods, better cars and aircraft, as well as better light bulbs and household appliances"

“the entire human body could be incredibly enhanced by means of technology: unbreakable bones, eagle-eye vision, and a bloodhound’s acuity of smell”

“manufacturing at the molecularly precise scale could take today’s waste and pollution and use it to fabricate products of heretofore unheard of quality”

“end of scarcity of food, knowledge, and other critical things”

“times ahead hold promise of bounty and abundance for everyone, not just today’s stakeholders of wealth and power

domestic manufacturing: “obsolete nearly all of the basic underlying assumptions of our economic and social institutions, the usages of currency, the nature of employment, and how we structure our daily activities

as a joke from myself, everybody is unemployed and wealthy except the teachers: “productive human work will require education, training and mental discipline .. drop our of school would be dropping our of life for all intents and purposes”

there shall be not only plentiful resources for all, but also the health and lifespan to enjoy them, longer life span will lead to

“sense of consequence” as “future generations will not be the only ones to inherit pollution, deficits and foolish politics”

Dystopian visions

Bill Joy in Wired (2000):

“an accumulation of great power and, concomitantly, great danger … far easier to create destructive uses for nanotechnology than constructive ones”

unlike potential dangerous technologies such as nuclear weapons, will “not require large facilities or rare raw material, Knowledge alone will enable the use of them”

ability to control nanomachines may be lost even to the technologist, self-replicating assemblers could run wild, capable of obliterating life

“gray goo” scenario in which nanomachines spread like bacteria – reducing biosphere to dust in a matter of days

to make it look less esoteric: small disasters of our current technology, e.g. drug resistant bacteria, nuclear accidents and oil spills are mentioned

confluence of nanotechnology and biotechnology may lead to “our own extinction” where the environment is destroyed by “gray goo’ and technological accidents, mankind

“gradually replaces ourselves with our robotic technology”