News Release:
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Nanotech Takes a Giant Step <u>Down!</u>

MIT says an army of NanoWalkers (microbots) will be performing sub-atomic operations within three months. The development signals a new era in technology as industry prepares to move "down" from genomes to atoms.

Thumbelina with an attitude: Hundreds of three-legged robots the size of a thumb, complete with onboard computers, powerful microscopes, and biosensors will be ready to manufacture nano-scale materials by mid-2002, according to researchers at the Massachusetts Institute of Technology (MIT) Bioinstrumentation Laboratory. A 'nano' is a measurement of one-billionth of a meter. Only 32 millimeters in diameter, the microbots are designed to manipulate atoms. Responding to infrared signals allowing each microbot to act independently or collectively on myriad tasks, the little machines (dubbed "NanoWalkers") are capable of executing 48 million instructions and making 4,000 nano-maneuvers per second. MIT expects to have at least 300 microbots hard at work in an enclosed card-table sized chromium chamber by June. The chromium surface provides an energy source for the robots which will receive their marching orders from a master computer in the box's ceiling.[i]

The micro-army is expected to manipulate individual molecules and even re-arrange atoms. Capable of making 200,000 measurements per second, the machines may initially be used to analyze chemicals and to assist in the development of new pharmaceuticals. However, there is no obvious limit to their job description, including the assembly and repair of fellow microbots and the eventual construction of still-tinier nanobots.

Weapons of mass construction: Described by their inventors as a bunch of "line dancing bar stools",[ii] the first microbot assembly line is only one of many such initiatives. Literally dozens of university and corporate labs are in a race for nanotech's Holy Grail - molecular self-assembly. Financial backing for the leading MIT venture has come exclusively from the non-profit Seaver Institute in Los Angeles. Around the world however, much of the funding for the high-risk research is coming from defense establishments and/or earmarked national nanotechnology initiatives. Another project, at UC Berkeley (Berkeley campus of the University of California), is developing a miniscule flying machine modeled after the lowly blowfly (*Calliphora*). Begun in 1998 and funded by the U.S. Defense Advanced Research Projects Agency (DARPA) and the U.S. Office of Naval Research, the "Nano-fly" is intended to match the 'light-footed bar stools' on the ground, and undertake reconnaissance missions in the air as well.[iii] The U.S. Defense Department is a major investor in nanotechnology, with publicly disclosed expenditures of $180 million in 2002.[iv]

"Gray goo" with "gray matter": News of the MIT breakthrough has been circulating since last December and appeared in some media reports in late January, but the MIT revelation, disclosed March 1st by *TechReview.com* (the online edition of *Technology Review* magazine) comes as a shock to many – including some intimately involved in nanotechnology. At a meeting sponsored by ETC group and the Dag Hammarskjöld Foundation last June, the President and CEO of Nanophase (a nanotech start-up or "nano-nicher") predicted that molecular self-assembly (including nanobots capable of building themselves) would never come to pass. In a feisty exchange with K. Eric Drexler (head of The Foresight Institute – a nano think-tank) in *Scientific American* last September, Nobel laureate

Richard E. Smalley prophesied that "nanometer-scale robots" would "never" be developed. [v] Smalley founded the nanotech programme at Rice University and his own start-up enterprise, Carbon Nanotechnologies Inc., on the side. The latest developments at UC Berkeley and MIT may bring "never" much closer to hand than Smalley anticipated.

For some time now Eric Drexler and more recently, Sun MicroSystem's chief scientist Bill Joy have been warning that nanoscale construction could lead to a "gray goo" if self-replicating inanimate matter multiplies uncontrollably. Microbots, capable of using individual atoms as building blocks, represent a giant step in that direction. Laden with their own computers and souped-up STMs (scanning tunneling microscopes), wireless three-legged "bar stools" could turn gray goo into the "gray matter" we associate with two-legged critters.

Tiny tech's giant step: Nanotechnology has been running below most peoples' horizons for a decade but it is now poised to compliment and possibly replace biotechnology. Since the Dag Hammarskjöld / ETC group seminar last June (the first global advocacy CSO meeting on the technology), three venture capital groups have been spawned dedicated to nanotech, and the industry now has a trade association – NanoBusiness Alliance (NBA). Governments from China to the USA have jacked up their funding for basic nano research, despite a general recession. The U.S. Government has allocated $604.4 million for its National Nanotechnology Initiative in this fiscal year.[vi] In 2002 the total in public, corporate, and venture capital investment in the 'tiny tech' may reach $4 billion.[vii] More surprisingly, and in contrast to the history of biotech, the U.S. market for nano-materials and finished products last year was ten times global R&D for 'tiny tech' - about $45.5 billion.[viii] According to the NBA (dubbed the "National Buckyball Association", by industry critics), the U.S. National Science Foundation places the total nano market at $1 trillion by 2015.[ix]

Water into wine? The scope and impact of nanotech was brought home last week by researchers in Spain working with Kraft Foods (a subsidiary of Phillip Morris, the world's second largest food processing enterprise). Kraft's Nanotechology Lab, in conjunction with Spanish universities, is developing a nano liquid "coating" for other liquids that among other things could revolutionize the global beverage market. While the potential for cellular surgery and the vast paint and dye market is huge, Kraft is enamored with the potential to design nano-capsules containing the colour, fragrance, and taste of tens of thousands of different drinks.[x] As Kraft sees it, consumers would buy a generic liquid containing the multiple-choice capsules (ranging from fruit juices to colas to wines and spirits). By exposing the beverage to different ultrasound or radio frequencies, the desired concoction would be released. Households would likely need nothing more sophisticated than a microwave-type device. In the booming world of nanotech, such a kitchen gadget could serve a number of purposes. Whether the farmers whose livelihoods depend on orchards, vineyards, and cereal crops are as flexible, is doubtful.

Political nano: "The developments of the past few days should make it clear to everyone that nanotech is coming on fast and strong," says Silvia Ribeiro of the ETC group in Mexico. She adds, "Industry is moving 'down' from genomes to atoms. Since atoms can be manipulated below the level of living material, much of the research has evaded the scrutiny of policy-makers and of civil society." ETC group's Hope Shand agrees: "Unlike biotech, nanotech works with animate and inanimate matter across every industrial sector. Every kind of corporation is involved, but until recently, most observers have ignored the implications for the life sciences." "Nanotechnology must become a serious issue for the Rio+10 summit (World Summit on Sustainable Development, Johannesburg, August 26 – September 4, 2002). If governments don't address it there, we could find ourselves dealing with social and environmental issues that will make biotech look insignificant," concludes Pat Mooney of ETC group in Canada.

BACKGROUND - tempest in an (itty-bitty) teapot: The possibility of self-replicating nano-machines has inspired debate and derision for years. Richard Smalley has calculated the barriers facing a single nanobot, capable of building at a speed of one billion atoms per second, would take 19 million years to build a 30 gram (less than one ounce) product. Such a pace would certainly take Kraft out of the fast food market. But, if one nanobot could build another, then a billion nanobots could become a billion billion little workers in 60 seconds. An army this size could crank out about 50 kilos a second of the desired end product – be it a Big Mac, a Mac Apple, or the Big Apple.[xi]

Which is where the "gray goo" alarm bells start to ring. What if no one switches off the multiplier and an exponentially exploding swarm of nanobots concludes that a planet full of chalk markers (calcium carbonate) is an idea whose time has come? Or, what if – like people and software – the nanobot blueprint mutates or develops a virus? By the time you perceive a problem on the horizon, the problem *is* the horizon.

Where Drexler believes this is possible, Smalley does not. The Nobel Laureate argues that a nanobot's "fingers" are too fat and sticky to manipulate single atoms since the fingers themselves would be the same size or bigger. Whether single-atom maneuverability is really a problem or not, nanotechnology seems to be developing a number of different ways to organize matter. It now seems possible to push relatively large quantities of atoms around with electro-magnetic fields or even with sound waves. Once blocks of atoms are bound together, the nanobot "finger" factor is history. Even at the scale of fifty or more nanometers (it takes almost a billion nano particles to cover the head of a pin), quantum physics takes over from macrophysics and the properties of elements alter dramatically. Elements respond differently to pressure, temperature, light, and everything else – and the crumbling calcium carbonate that teachers us on chalkboards morph into the incredibly tough shell of the abalone.

ETC group is completing a kit for civil society organizations and policy-makers on nanotechnology and will be publishing an ETC Communiqué on the same subject later this month. ETC group wishes to acknowledge and thank Mathew Charron whose research was central to this news release and who has been volunteering his time with us at our Winnipeg headquarters.

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The Action Group on Erosion, Technology and Concentration, formerly RAFI, is an international civil society organization headquartered in Canada. The ETC group is dedicated to the advancement of cultural and ecological diversity and human rights. www.etcgroup.org

Endnotes:

[i] Cameron, David, "Walking Small", *Technology Review* website (www.techreview.com), March 1st 2002.
[ii] Graham-Rowe, Duncan, "Lord of the Dance", *New Scientist*, May 26th 2001, pages 22-23.
[iii] Kontzer, Tony, "Get the bugs in" (www.informationweek.com), December 3rd 2001. InformationWeek.com is part of the TechWeb Business Technology Network.
[iv] [iv] Figures downloaded from the National Nanotechnology Initiative website (www/nano.gov/2002budget.html) on March 5, 2002.
[v] Smalley, Richard E., "Of Chemistry, Love and Nanobots". *Scientific American*, September 2001, p.76.
[vi] Figures downloaded from the National Nanotechnology Initiative website (www/nano.gov/2002budget.html) on March 5, 2002.
[vii] ETC group makes this estimate based upon a number of business and government sources in several countries. In general, the European Union and Japan have governmental budgets that approximate U.S. Government spending on nanotech. Corporate spending in 2002 may match or exceed government spending and venture capital funds are also becoming a major factor. In addition, China and the "Asian Tigers" are making very large commitments to the new technology.
[viii] Tinker, Nathan, *2001 Business of Nanotech Survey*, NanoBusiness Alliance, October 2001, p.4.
[ix] Tinker, Nathan, *2001 Business of Nanotech Survey*, NanoBusiness Alliance, October 2001, p.6..
[x] Choi, Charles, "Liquid coated fluids for smart drugs, food", United Press International (www.upi.com) , New York, Feb. 28th 2002.
[xi] Smalley, Richard E., "Of Chemistry, Love, and Nanobots". *Scientific American*, September 2001, p.77.