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## Molecular Manufacturing Moves to Mainstream

**Chris Phoenix**  
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Molecular manufacturing is a way to build nanoscale machinery. It involves controlling individual molecule-building reactions to form complex molecular structures. If the machinery thus constructed can be used to do the molecule-building, then a few machines could be used to make as many as required. This implies the rapid development of large-scale manufacturing.

To date, molecular manufacturing has been largely ignored and even scoffed at. A lot of advanced, wild, and even impossible ideas have become associated with it. Nanoscale technology researchers have another reason to downplay it: they are afraid of public fear hurting their work. For example, the U.S. National Nanotechnology Initiative has not yet funded any proposal directed at developing it.

Recently, there has been an effort to demystify molecular manufacturing and to show that it is neither impossible nor insignificant, but simply a very powerful approach to nanoscale construction. My organization, the Center for Responsible Nanotechnology, has been at the forefront of this effort. We have made steady progress, and expect to make much more progress in the coming year.

In 2005, we expect that scientists will pay increasing attention to molecular manufacturing, evaluating the actual proposals and theories. Institutions also may begin to pay attention. Serious attention to the actual proposals of molecular manufacturing will have a self-reinforcing effect, making it more acceptable for other researchers and institutions to pay attention to it.

This will open the door to researching the implications that molecular manufacturing could have. This work is urgent, since no one knows how rapidly a general-purpose manufacturing technology could be developed. Those who have studied it most closely fear that development could happen with disruptive speed and power, and new institutions may need to be created in advance to deal with new problems.

More attention also brings us closer to openly acknowledged development. Despite the worrisome possibilities, we believe this is probably a good thing. Nanoscale technologies are rapidly making molecular manufacturing more accessible, increasing the possibility of a successful secret attempt—which seems more dangerous than an open attempt. Also, the later it is developed, the faster it will be possible to develop it, and part of the problem is that excessive speed would leave no time for wise policymaking. A final reason to favor early open development is that molecular manufacturing's access to the nanoscale could help to solve a lot of pressing global problems. For all these reasons, we think that more attention to and respect for molecular manufacturing will be a positive development in 2005.

*This essay is original and was specifically prepared for publication at Future Brief. A brief biography of Chris Phoenix can be found at our main [Commentary](#) page. Recent essays written by Mr. Phoenix can be found at his [Center for Responsible Nanotechnology](#). Some earlier essays are archived at [Nanotechnology Now](#). He receives e-mail at [cphoenix@crnano.org](mailto:cphoenix@crnano.org). Other websites are welcome to link to this essay, with proper credit given to Future Brief and Mr. Phoenix. This page will remain*

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## **Predictions on Russia**

**Dr. Peter Lavelle**  
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Vladimir Putin's Kremlin will complete the creation of the world's largest energy corporation, comprising of natural gas giant Gazprom, Rosneft, possibly Sibneft and the largest production unit that was part of Yukos.

Mikhail Khodorkovsky, former head of Yukos and on trial for fraud, tax evasion, and embezzlement, will be sentenced to at least 10 years in prison.

Russian-American relations will not improve, nor will they worsen. The administration of George W. Bush will continue to engage Russia via the close personal relationship Bush and Putin have. While not a supporter of the war in Iraq, the Kremlin will support American efforts to stabilize the political and security situation there.

The Kremlin will not embark on another large-scale campaign against the country's oligarchs. However, when Russia's Audit Chamber releases its report on privatization of former Soviet assets in spring, some re-ordering of privatizations will result.

Having consolidated and re-organized the energy sectors under Kremlin control, Putin will push a new agenda to reform the state's administrative apparatus. This reform agenda should be seen as part of Putin's drive toward centralized control and the creation of a unitary state.

The status quo in Chechnya will largely remain the same. However, there is hope that Putin will follow through on his recent announcement that Russia will invite European institutions to assist Russia to find a lasting settlement in the war torn republic.

The possibility of another large-scale terrorist attack akin to the Beslan tragedy remains high.

Russia's economy will continue to expand. Administrative reforms will attempt to help Russia diversify its economy away from heavily reliance on the energy sectors. The middle class will also continue to grow on the back of higher wages and, hence, expanded spending power.

The Kremlin will tread more carefully in the post-Soviet space. Miscalculation in Ukraine's domestic political affairs will translate into a more sophisticated approach when dealing with change and continuity in what the Kremlin calls the "near abroad."

While continuing to engage European institutions on a wide array of issues, Russia will strengthen ties with China and India through trade and joint ventures in Russia's energy sectors.

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The Kremlin will work with Ukrainian president Viktor Yushchenko. Far from "loosing Ukraine ," Russia and Ukraine will develop a more modern and mutually beneficial relationship based on democratic values and trade.

Russia 's political opposition may not unite behind one party or one political figure, but will formulate a unified agenda in competition to the Kremlin's. There will be no "orange" or "people's" revolution in Russia , but Russia 's civil society will start to be politically more self-confident.

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## **Nanotechnology Will Change Everything**

**Jeffrey R. Harrow**  
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Nanotechnology will continue to (slowly) accelerate along a road that will *change everything!*

As we continue to learn more about, and get better at bending billionths-of-a-meter size particles (which can be individual atoms and molecules themselves) to our will, we're going to find ourselves doing things and building things and using things in the same way, and at the same scale, that Nature has been doing since the beginning of time.

For a few examples of nano-research ongoing during 2005 that may well lead to early end results (most in the labs this year, commercializing beyond 2005), consider:

- Multi-terabit non-volatile memory that will change how we use and store data; and computers so fast that today's will seem like turtles.
- Bottom-up manufacturing, using techniques such as self-assembly, that will be more efficient and environmentally friendly than today's crude top-down methods.
- Materials that are custom made to the attributes needed for a specific application, such as incredibly light and superconductive wires ten-times stronger than steel; nano-sized semiconductors; more efficient solar cells; and wall paint that can illuminate a room.
- Nano-combustives, where nano-sized particles of reactants have a far greater surface area than conventionally sized particles and so burn far faster, generating more power for rocket fuel and explosives.
- Voluminous breakthroughs in biology and genetics and proteomics and medical sciences that will result in designing drugs by intent rather than through today's hit-and-miss

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processes; individually personalized drugs that will increase efficacy and reduce side effects; and perhaps the injection of tiny molecular "machines" that are not nano "Roto-Rooter" mechanical monsters, but are tiny drug-carrying spheres that use proteins to seek out and kill individual cancer cells or dissolve plaque.

- And far more than we can, today, possibly imagine.

If this seems an improbable journey, look back ten years and see if you could have predicted the very real economic and social impacts that advances in just a few areas have brought: faster, cheaper, and pervasive computers; pervasive and higher-speed networks, especially the Internet with its traditional capabilities and recently-popular VoIP services that are changing the very nature of "telephone companies;" instant access to information (the Web and Email) that have radically changed how people shop, communicate for business and pleasure, and even get their "news;" or how Bloggers are rapidly changing the face of traditional journalism and transforming the "Fourth Estate."

Now, try to look forward ten, or even five years, to predict the results of our harnessing the most basic ways that everything in our world, and we, are built. If today seemed unimaginable ten years ago, then the world of ten years from now (since breakthroughs are now happening exponentially faster) is elusive indeed.

We can't (and shouldn't) stop such progress, but we are going to have to live with the results of massive transformation.

Nanotechnology *will* change everything.

Don't Blink!

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## **Emerging Planetary Futures**

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[\(read his bio\)](#)

Those who have been displaced by Modernity have come back to contend for ownership of the global future. In its quest for progress, the modern story cast off religion and fundamentalism (too tribal) and the planetary and spiritual (too idealistic and irrelevant for progress).

But the displaced have come back and are challenging the modern—first in the global imagination and then as global reality.

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Under threat are the modernists: globalized, yet champions of the nation-state; secular, but values based. They had assumed the future was clear: more freedom of capital, prosperity overtime for all, and the end of religion and other isms. But this has not happened. Fundamentalists, cultural creatives and techno-utopians all lay claim to the future.

In the last elections in the USA and Australia , it was the fundamentalists, as in other nations, who were pivotal. They voted for the imagined past, when men were really men, when it was god and a big stick that ruled the polity. God does take sides and one can vote for Him. Modernists acceded to this, unconsciously knowing that deep underneath the myth of progress was the myth of heaven.

Cultural creatives had hoped that their values and practices of gender partnership, sustainability, global ethics, global governance and a personal spirituality would have swayed the election to different results. But fear of terror and fear of the loss of accumulation meant that the present looked to the past as its future.

Still it is too easy to rule out transformation. With study after study showing that our patterns of thinking, our behavior are dramatically implicated in our personal and civilizational health (those with strict deadlines are more likely to get heart attacks; those who forgive have healthier immune systems), the cultural creatives are here to stay. This demographic group also does not shy away from the latest technologies; their children are the digital natives.

But what augurs well for the fundamentalists is the speed of change. Dramatic advancements in genetics, brain science, virtual realist will continue. In response, most will seek comfort in what was.

However, what is new is the blending of the gaian image (sustainability, planetism) with techno-utopianism—resulting in the green techie. There is even a new videogame that links biofeedback to computer gaming. The seeds of a linked gaia with technologia are emerging.

While it appears that the future will see more fundamentalism tied to modernism (and both are in unsettled tension) the spiritual and techno utopians are slowly creeping in and transcending the walls by making them virtual and seeing them as illusory changing the nature of the wall.

An episteme earlier, the battle in the medieval city between priest and knight was resolved by those who lived outside the city walls—the traders—and modernity was born. We are in the midst of the end of the modern system as well. All signs lead to a break from the present, even as the past desperately clings to our unconscious fears.

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