Radical Technologies, Rapid Change, and the Real World

Exploring a scenario series developed by the nonprofit Center for Responsible Nanotechnology

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www.crnano.org
Industrial Revolutions

First Revolution
(1780–1840)
Based in *United Kingdom*

- Steam Engine
- Textile Industry
- Mechanical Engineering
Industrial Revolutions

Second Revolution
(1840–1900)
Based in Europe –
England, France, Germany

- Railways
- Steel Industry
Industrial Revolutions

**Third Revolution**
(1900–1950)

*Based in United States*

- Electric Engine
- Heavy Chemicals
- Automobiles
- Consumer Durables
Fourth Revolution
(1950–Present)
Based in Pacific Basin –
California, Japan
- Synthetics
- Organic Chemicals (Oil)
- Computers
The Next Industrial Revolution

Fifth Revolution
(2010? – ??)
Based in Developing World?
China? India? Brazil?

- Nanotechnology
- Molecular Manufacturing

Sunday, July 27, 2008
Industrial Revolutions

Societal Impacts

Time (Measured in decades)
Accelerated Impacts

Industrial Revolutions

Molecular Manufacturing Revolution

Societal Impacts

Time

Sunday, July 27, 2008
Radical Technologies

- Biotechnology & genetic engineering
- Neuroengineering
- Artificial intelligence
- Geoengineering
- **Advanced nanotechnology**

“Using sophisticated nanoscale machinery to construct powerful products with molecular precision...”

Some experts think this may be achieved as early as 2020.
Productive Nanosystems:
From molecules to superproducts

Version 1.1
Introduction of Nanofactories

Technical Progress

Societal Impacts

Time

Sunday, July 27, 2008
Recent Developments

December 2006:
The U.S. National Research Council releases a study reviewing the theoretical basis of molecular manufacturing and calling for funding of experimental research...
July 2007:

DARPA issues a request for proposals to develop tip-based nanofabrication at the threshold of atomic precision...

Technical Progress
Recent Developments

October 2007:
The U.K. government announces grants to research teams developing nanomachines that can build materials molecule by molecule...
Recent Developments

December 2007:

A years-long effort to explore how current laboratory techniques for atomically precise fabrication can be extended, step by step, toward increasingly advanced products and capabilities results in a “Technology Roadmap for Productive Nanosystems”...

Technical Progress

Sunday, July 27, 2008
March 2008:

A potentially powerful new form of nanoscale computing is developed by scientists in Japan. BBC News describes the development as a "tiny chemical 'brain' which could one day act as a remote control for swarms of nano-machines"...
For 2007, the major project of CRN’s Global Task Force was to produce a series of professional-quality scenarios of a near-future world in which exponential general-purpose molecular manufacturing becomes a reality over the next 15 years...
In pursuing this project, CRN pulled together more than 50 people from six continents, with a range of backgrounds and points of view, as collaborators...
Scenario Creation Process

Over the course of several months, a unique series of “virtual workshops” — using a combination of teleconferencing, Internet chat, and online shared documents — produced a range of intriguing scenarios.
Across eight separate storylines, our international team of policy, technology, and economic specialists imagined in detail a range of plausible, challenging events —

*From pandemics to climate crises to international conflicts* —

To see how they might affect the development of advanced nanotechnology...
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A scenario series developed by the nonprofit Center for Responsible Nanotechnology

Sunday, July 27, 2008
Eight Scenarios

Scenario 1: Secret Military Development
Scenario 2: Positive Expectations
Scenario 3: Negative Drivers
Scenario 4: Presidential Commission
Scenario 5: ... And Not a Drop to Drink
Scenario 6: A Goal Postponed
Scenario 7: Newshound Notebook
Scenario 8: Breaking the Fever
Scenario #1

**Secret Military Development**

When the Democratic Party retakes the White House in 2009, most observers expect that how the new President deals with the implosion of Iraq and the ongoing "war on terror" will dominate the headlines over the course of his term in office. These observers are correct — but not for the reasons they believe.

Terrorism and war would certainly remain vital national issues for the new administration, but they are overshadowed by the emergence of a provocative new tool for both the U.S. and its adversaries…
Scenario #2

Positive Expectations

When the first version of RepRap — the “replicating rapid-prototyper” — is released in early 2008, critics have a field day. It's slow. It's clumsy-looking. It can't actually replicate itself without adding a few key commercial parts. But where critics see an ugly duckling, design students and open source enthusiasts see a swan-in-the-making. Meanwhile, forward-looking strategists at mega-retailers and mass manufacturers feel a distinct chill run up their collective spine…
Scenario #3

- **Negative Drivers**

What a difference a year can make. In early '09, when the new president took office, all of the news was about just how tolerant and forward-looking the American public had become. Some of us even dared to have some hope for the future. Not the scientists, though. The World Health Organization had been fearing mutations in the H5N1 flu virus that would allow non-avian vectors since 2006. Little did we know that, before the president had issued his first state of the union address, we were already lost—and the WHO had missed the real threat. Everyone called it The Rot…
The present struggle over dominance in the arena of molecular manufacturing technologies does not derive from a single cause. The Commission found that the widely-held view that the crisis arose due to misbehavior on the part of non-governmental research groups does not in fact explain the origins of the present situation; neither does the analysis, more prevalent in academic circles, that the nanotechnology strategies of the current generation of Russian leadership triggered the crisis. The position held by the opposition party, that the crisis derives from a series of policy missteps on the part of the current and previous administrations, is equally insufficient. Alone, each of these explanations is incomplete…
Scenario #5

... And Not a Drop to Drink

Water is crucial to the tiny island nation of Singapore. Surrounded by the salty sea, they get 50 percent of their potable water from rainfall and must import the other 50 percent. In 2009, terrorist attacks severely damaged the massive Malaysia-Singapore water pipelines. Among the top suspects was Jemaah Islamiyah, a group of Southeast Asian Islamic Jihadists based in Indonesia but with cells in Malaysia. Neither Malaysia nor Singapore were eager to pay for rebuilding the pipeline, and their relationship became increasingly difficult and antagonistic; in the end, no new agreement was reached. Draconian water conservation efforts were initiated in Singapore starting in early 2010, and the compliant populace went along...
A Goal Postponed

The middle of the first decade of the millennium saw a slow shift toward acceptance of molecular manufacturing. Not only its proponents, but unaffiliated scientists as well, began to acknowledge that the idea of molecular machines building molecular machines might be worth pursuing. The supporters of the approach began to draw a cautious breath of relief. Few observers close to the field expected molecular manufacturing to be a victim of its own success. In hindsight, the irony was inescapable and almost predictable: each partial success and modest step forward siphoned off more and more interest from the ultimate goal of exponential nanoscale manufacturing using molecular tools...
Scenario #7

Newshound Notebook: 2013-2018

Huge numbers of disaffected Chinese are now taking part in organized protests, often resulting in clashes with police and military riot squads. By “organized,” I don’t necessarily mean planned and announced in advance. Flash mob actions are far more common; people tell each other by mobile phone and t-pad (texting) where they’re going to meet and then, suddenly, thousands are there. Sometimes tens or even hundreds of thousands. The government tries to stay ahead of these events by monitoring civilian electronic communications and by using sophisticated satellite image analysis to predict the direction of mob flows, but it doesn’t always work…
Scenario #8

**Breaking the Fever**

Global warming skeptics used to claim that the models climatologists used were wrong. Much to everyone’s surprise, they were right. Unfortunately, they were right in the wrong way: the models weren’t wrong because they over-stated the impact of global warming; they were wrong because they so severely under-stated it…
Important Note

These scenarios are not predictions, and do not represent outcomes desired by the Center for Responsible Nanotechnology. CRN intends the scenarios to provide a springboard for discussion of molecular manufacturing policies and societal responses.
Important Note

While each scenario can be understood individually, the real value of the process comes from the comparison of multiple scenarios. A strategic response that appears robust in one scenario may be dangerous in another; an organization, community, or polity using these scenarios to consider how to handle the emergence of molecular manufacturing should strive for responses that are viable across multiple scenarios.
What you can do next!

✓ Take your FREE copy of all 8 scenarios on CD home or to work with you

✓ Read the full scenario series online at: http://crnano.org/CTF-Scenarios.htm

✓ Discuss them with your family, friends, and colleagues

✓ Ask how each scenario might affect you directly

✓ Come up with new ideas for scenarios and share them with CRN!