Center for Responsible Nanotechnology

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 her 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.

Primitive computer-controlled fabrication machines, often called "fabbers" or "3D printers," had been available to universities and commercial manufacturers since the mid-1990s, but over the new century's first decade, this technology sees a dramatic drop in price combined with an equally-dramatic increase in sophistication. By 2009, these devices can easily "print" inexpensive electronic devices, low-efficiency photoelectric materials, and most "dumb" plastic products. Moreover, they prove able to make most of their own parts, the remainder being easily and cheaply obtained from hardware stores or by online mail-order. Refrigerator-size 3D printers more powerful than the best industrial fabbers of a few years earlier can be had for the cost of a used car.

These systems operate at the "meso-scale" of small-but-not-microscopic raw materials—resins, powdered solids, and other forms of "fabber toner." This technology isn't even close to precise molecular manufacturing, but for the first time, industrial designers as well as "do it yourself" hardware hackers can treat the material world like just more software. By the end of the decade, most universities have fabber design classes, and the "open source objects" movement rapidly gains steam (along with concerns about "product design piracy"). *TIME* magazine puts a $1500 Hewlett-Packard ThingJet on its July 2, 2010, cover, asking "Is this the decade of fabrication?"

That same year, even as American forces complete their withdrawal from Iraq and redeployment to Afghanistan, consumers around the world buy desktop 3D printers by the truckload. Most buyers don't quite know what they'll use the devices for, however; by the beginning of 2011, the "3D printer" section of eBay is among the largest categories on the site. One group of consumers, however, knows exactly what they want to do with fabbers.

In early 2011, a U.S. forward operations base outside of Kandahar is inundated with several hundred small automated aircraft (unmanned air vehicles, or UAVs), each carrying a small explosive. Most fail to go off, but casualties are significant enough to be headline news around the world. Military analysts quickly realize that these micro-UAVs had been fabbed, using a hacked version of a popular radio-control toy as a base design. Over the next few months, micro-UAV attacks continue to rattle U.S. and allied forces, but this brief fab-weapon experiment by Taliban and Al Qaeda forces in Afghanistan is soon cut short as allied ground forces successfully refine their active defense capabilities using a new generation of vehicular and robot-mounted anti-aircraft systems. Few realize, however, that even if it is no longer a threat to the military, the printed UAV (referred to by troops as "Easy-Bake missiles") concept still will have its uses.

As meso-scale 3D printers proliferate across the U.S. and Europe, fabrication technologies continue to advance, and ongoing university and corporate research in DNA-controlled molecular assembly of nanoscale devices & structures finally begins to see more than token improvements. In late 2011, a research team in Tokyo announce a breakthrough regarding pseudo-RNAcontrolled replication of non-organic nanoscale structures; around the same time, a German lab reports preliminary designs for a DNA-controlled system for pharmaceutical research and development. The "decade of fabrication" begins to take on a distinctly biological appearance.

Despite the successful response to the micro-UAV attacks, the overall military situation for the U.S. and its allies in Afghanistan seriously degrades throughout 2011, and by the next year, squeezed between failing public and UN support for the Afghanistan quagmire (with many calling it a repeat of Iraq), the U.S. president announces a hasty withdrawal. Islamist websites trumpet the second mujahideen victory against a global superpower in half a century. The president announces that she will not seek re-election, throwing the already-raucous presidential race into turmoil. The new president wins by less than a single percentage point, and vows to govern as a "coalition" leader, drawing on figures from both major parties for cabinet positions.

In early 2014, without warning, a highly coordinated rash of biochemical attacks are carried out simultaneously in New York, Washington DC, Houston, and Los Angeles using hundreds of fabbed micro-UAVs as carriers. Outbreaks of the highly virulent influenza agent spread quickly, but are contained by aggressive quarantines enforced by declarations of martial law and the application of executive orders on the books since the mid-1990s. The rapid identification of the pathogen and quick development of a treatment limit deaths to a few thousand, but the panic of millions attempting to leave affected areas leads to widespread disruptions in all kinds of systems. Several Islamist groups claim responsibility, and government analysts quickly determine that the UAV design used had been available since the end of the Afghan War.

Congress hastily passes the Fabrication And Bioterror (FAB) act, broad legislation regulating advanced desktop fabrication devices, biomedical labs, and processes that deal with the engineering of biological organisms. The law's definition is so broad and vague that many researchers fear that advancements in recently developed commercial DNA-controlled manufacturing techniques could be classified as illegal. Debates over patents, however, are drowned out by debates about public security.

The President asks a panel of technological and military experts to look at what might be on the near horizon in terms of manufacturing capabilities, so that the U.S. isn't caught unaware. Upon receipt of the report, the President orders the initiation of PROJECT ROOM@BOTTOM, a black program to develop molecular manufacturing capability for classified intelligence and military use.

Throughout the rest of 2014, the FAB act requires 3D printer manufacturers to include oversight firmware in their products, and to force oversight code updates into existing units; while un-patched 3D printers remain in existence, they soon fall behind the capabilities of the newest products. Similarly, the FAB act institutes top-down controls on bio labs around the country, a bureaucratic nightmare that stalls American bioscience for months. In May of 2015, the FAB act sees its first major enforcement use. The FBI, investigating a complaint from chipmaker Intel, arrests the operators of a not-for-profit fabrication lab in Colorado, charging them with conspiracy, terrorism, and violations of the FAB act for their use of DNA-controlled fabrication techniques to build microchips. The allegations detail conspiracies with Iranian nationals looking to learn the techniques for use in weapons development programs (particularly the cheap production of missile guidance systems).

The accused are quickly convicted by the media, but in court, the trial proves surprisingly difficult. The Government makes a poor case that the Iranians in question are actually government agents, rather than plain civilians looking to apply the technology to peaceful uses, or even that they had intended to return to Iran at all. "Friend of the court" statements filed by similar not-for-profit fabrication labs, arguing the value of these facilities as ways to improve impoverished communities, further complicate matters. Overshadowing the legal particulars is the question of whether this particular kind of molecular machine qualifies as a "biological organism" just because it can manufacture a duplicate under controlled conditions, or as a "personal fabrication system" despite its clear industrial use.

In 2016, the Colorado Fab Lab case reaches the Supreme Court. By a vote of 6-3, the Justices overturn the defendants' convictions on conspiracy and terrorism charges, but uphold their convictions for violation of the FAB act. Dozens of community fab labs with similar models to the defendants' are shut down or forced underground as a result.

As the United States completes its withdrawal from foreign military entanglements, and focuses its attention on controlling tools used by the last set of terrorists, the up-and-coming superpower, China, doesn't rest. China uses its growing economic and military influence to secure favorable oil supply deals with the Islamic republics of Afghanistan, Iran, and Iraq, in exchange for weapons and mutual defense treaties. The U.S. government files token objections, but proves too distracted to counter China's increasing global footprint.

China is busy on another front, as well: since 2012, the Chinese military has been operating its own secret molecular manufacturing research project.

In February of 2017, the newly-formed Bolivarian Union, lead by Venezuela, Chile, Bolivia, and Peru, convenes its first meetings in order to initiate a democratic socialist trade bloc for Latin America. In response to continuing (if low-level) animosity with the United States, Venezuela begins loudly negotiating with China for a similar oil-for-defense deal as that made with the Middle East Islamic nations. When China secretly hints during negotiations about the imminent success of its own black nanofabrication program, Venezuela explicitly adopts a minimalist intellectual property (IP) policies, refusing to recognize foreign patents and copyrights, in order to accelerate cultural and technological development. It strongly campaigns for a similar policy among other BU members. American and European IP refugees and pirates set up server farms and make modest investments in telecommunications infrastructure.

That same month, PROJECT ROOM@BOTTOM produces its first viable molecular manufacturing facility. Over the next year, the project—rechristened the Federal Nanomanufacturing Defense Initiative—goes through a series of debugging and stability trials. The FNDI research team insists that it could iterate several generations of molecular fabrication devices in that time, but the bureaucratic management is cautious. Finally, by April of 2018, FNDI begins production and deployment of "smart dust" sensor surveillance systems in limited foreign theatres, as well as advanced aerospace and orbital surveillance and weapons applications. The entire production run of these new military devices, from initial design proposal to initial deployment, takes only about six weeks; FNDI staffers claim they could cut that down by two-thirds, easily.

The President, wary of a public that has learned to equate "molecular" and "fabrication" with "terrorism," decides that secrecy of the nanomanufacturing capability is paramount, even if it means under-utilizing its potential. Like the need to prevent overuse of intelligence garnered from the cracking of the German Enigma cryptosystem of WWII, the President establishes a theoretical threshold of "minimum strategic advantage" which must be breached before public knowledge of the program existence can be considered tolerable.

This doesn't mean that these new systems don't get used, however. In 2019, Operation Oracle, a joint domestic anti-terrorism effort by the Department of Defense and the National Security Agency, gets underway with full Presidential backing. Operation Oracle deploys millions of nanomanufactured surveillance bugs across the U.S., many disguised as routine radio frequency identification (RFID) tags. Using low-power mesh networks to avoid detection, the Oracle devices relay information back to NSA computer systems. The NSA is especially eager to use the FNDI's molecular fabricators to design and build ultra-high-speed computing systems, hoping for a brute-force method of breaking the quantum cryptography common among U.S. competitors.

At the same time, the Pentagon launches a series of top-secret wargames and simulations looking at alternative plans for the direct military use of nanofabricators. Scenarios range from just-in-time weapons production to seemingly-radical notions of weapon systems that "evolve" with each successive generation (with each new generation being as little as a few hours). Most of their scenarios assume the United States will deploy nanotechnology-derived weapons first, a reasonable conclusion given that economic competitors Europe and Japan remained mired in biological-model nanotech dead ends, and the CIA has found no evidence that the Chinese have any advanced nanotech research underway.

Keeping its research so clandestine has cost China time, and the Chinese molecular manufacturing project doesn't see success until early 2020. The Chinese prove less worried than the U.S. about public exposure, however. In August 2020, China announces the result of its black MM program by invading and disarming North Korea with lightning speed (the so-called "Six-Minute War"). Kim Jong Il's attempt at a retaliatory nuclear missile attack on South Korea fails to clear the launch pad as thousands of micro-UAVs descend upon the missile bases; the surveillance footage of the missiles being destroyed by swarms of micro-UAVs quickly tops the downloads at GoogleTube. The world is taken by surprise by the power of the new technology, but ultimately applauds the operation. Buoyed by this success, China begins earnestly revolutionizing every aspect of its society through nanomanufacturing.

Venezuela (along with the rest of the BU) immediately jumps on the bandwagon with a series of detailed treaty proposals, UN proclamations, and multilateral trade agreements, almost as if it knew that the Chinese military molecular manufacturing demonstration was going to occur. Seeing how the United States and Europe had been surprised by the Chinese deployment of molecular nanosystems, the remaining South American nations, including Brazil, seek to join the BU; by the year's end, several Central American states make overtures looking for adjunct membership.

In January of 2021, nanoscale Operation Oracle bugs are discovered by curious hardware hackers in Austin, Texas, trying to figure out why the RFID tags on cereal boxes behaved oddly. Soon, the bugged RFID tags are found by the millions in consumer products of every description. The U.S. tries to cast blame on China, calling for sanctions in the United Nations. European hackers eventually reverse engineer the bugs' operation and post their findings online. A combination of American FOIA requests, investigations by bloggers and journalists, and a brilliant civilian hack of the bugs which is used to gather intelligence from federal agencies reveals that most of the bugs report their data to the NSA; subsequent Congressional investigations reveal that the US has had a much greater capacity for molecular manufacturing for much longer than anyone has suspected.

Plagued by controversy and threats of impeachment, the President concedes the existence of the black program, but fights tooth and nail to defend the government's secrecy policy in the face of worsening oil shortages and China's new military vitality.

That's when promises made by nanotechnology enthusiasts over the past two decades come back to haunt the White House. Molecular manufacturing could make ultra-efficient solar fabric for pennies—but where was it when we needed to an alternative to Middle Eastern and Venezuelan oil? Nanotechnology could fulfill the possibilities of distributed design and manufacturing only hinted at by meso-scale fabbers—but where was it as the U.S. fell further and further behind its economic rivals? As China ably demonstrated, molecular fabrication could provide orders of magnitude improvement in military might—but where was it when the U.S. needed to balance out the new nano-superpower?

By the CRN Scenario Working Group (see INTRODUCTION)