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Nano-technology in 2050: A Mini-Scenario

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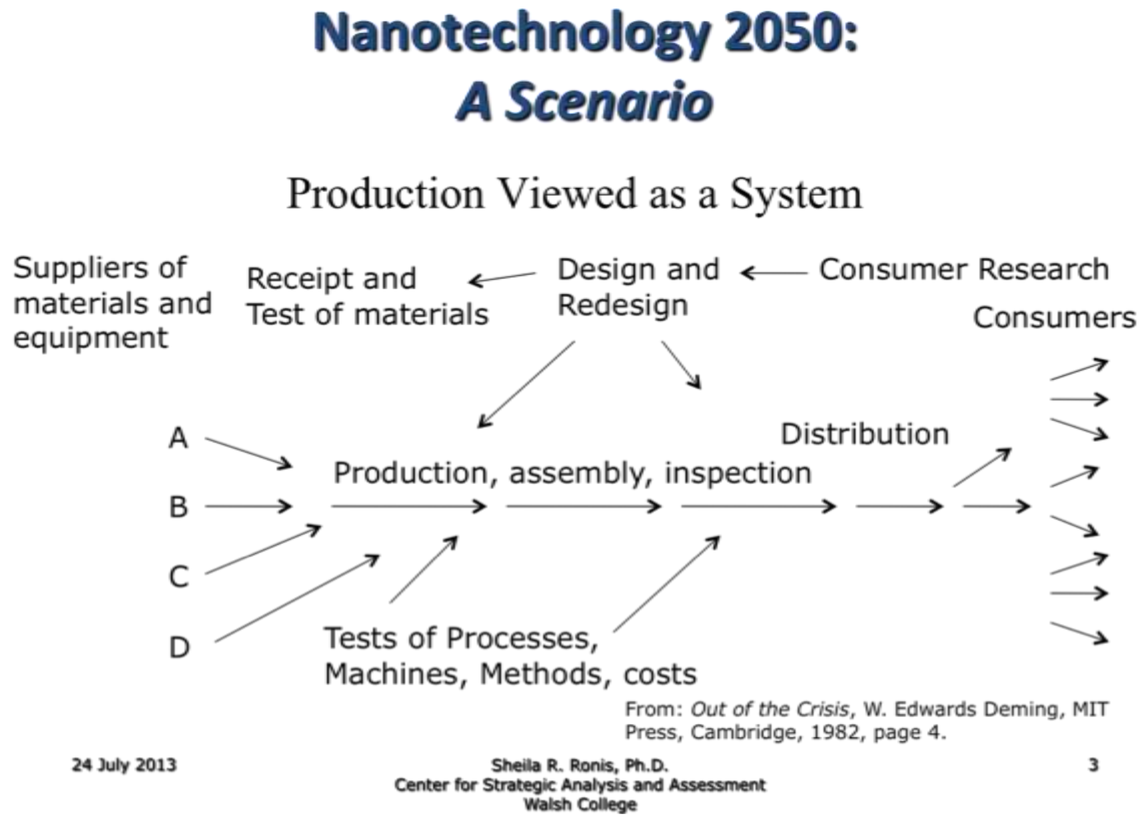
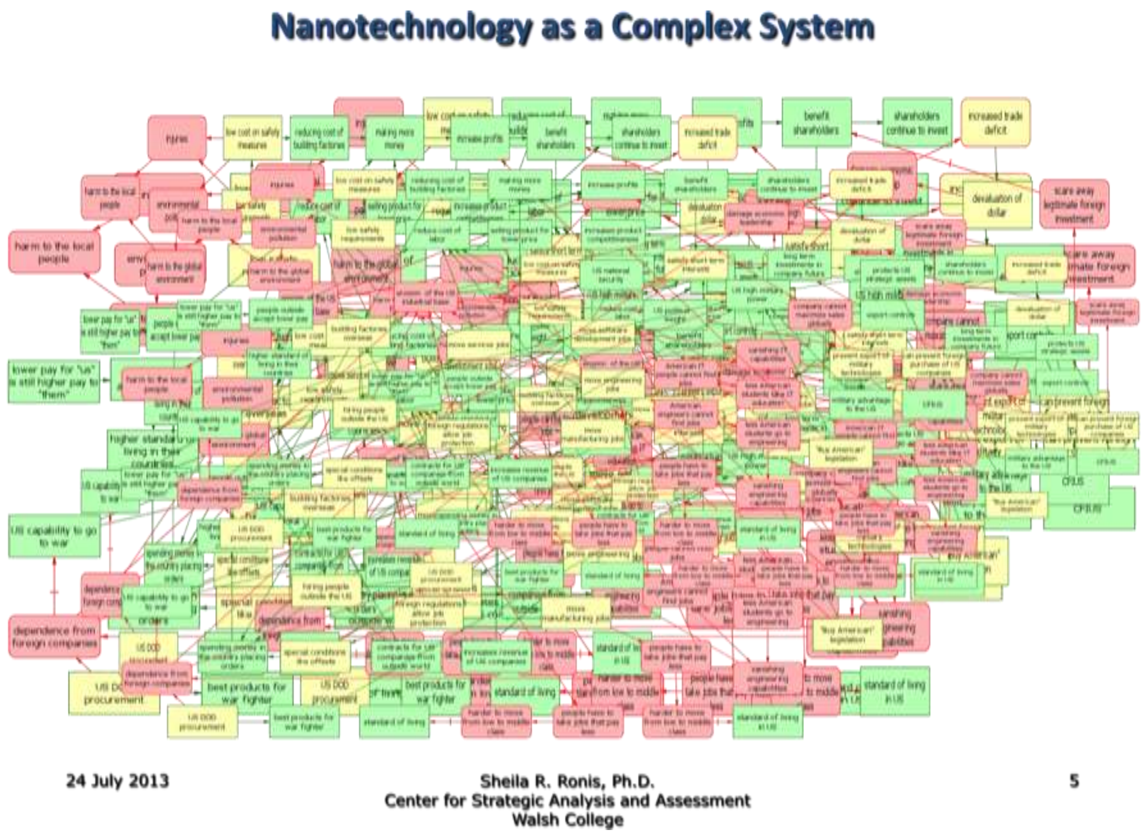
The date is July 13, 2050, the 100th anniversary of one of the most famous lectures of the 20th century, when at Tokyo's Industry Club in Japan, the American statistician Dr. W. Edwards Deming spoke to a group of senior officials representing 80% of the capital of the nation. In that lecture, he told the group of executives that Japan could revolutionize its manufacturing capabilities through quality programs and statistical process control, but most of all, by managing production as a system and he showed them a simple map. This led Japan to manage its country's manufacturing in specific industries as a system in order to win in the global marketplace.



Dr. Deming had been sent to Japan as a part of the Marshall Plan. And, even though he was never revered in his own country the way he was in Japan, Dr. Deming always hoped the U.S. would learn the right lessons. A hundred years later, it is clear that developing "grand strategies" for industries, as a system, have many advantages. Fifty years later, in the year 2000, the United States looked ahead to see how it could gain a competitive advantage in a strategic industry called nano-technology. Its grand strategy process began by the establishment of the National Nanotechnology Initiative that coordinated and integrated the entire federal government effort to ensure collaboration and the interagency would manage the emerging industry as a system. The system, with the nano production life cycle sub-system, included a map of what a successful nanotechnology industry in the United States might look like. Not only were the elements and critical success factors identified but also their interactions were considered.



Unfortunately, unlike Dr. Deming's elegant map of 1950, this map looked more like a bowl of spaghetti. The reality that the global nano system being identified was not only a "systems of systems" but a "complex system of complex systems." And, although they could not be controlled through policy or anything else, the more knowledge of the system that exists, the more likely those systems can be influenced.

Using Dr. Deming's 1950 map as a guide, the 21st century version was developed in 2014 to accommodate the myriad elements of the system. Today, the system includes basic nano-technology sciences incorporating the physics, chemistry and biology of the very small, the feasibility of applying the science beyond the laboratory, designing and engineering the tools for scaling production in order to develop products capable of being commercialized in the marketplace for nano-bots, materials, biological and chemical agents, electronics, medicines, surgical tools and the thousands of other nano products in our everyday lives. The life cycles also include tagging and recycling, since all nano particles on the planet are supposed to be tagged and recycled by law, at least in the West. By 2030, nano products are already ubiquitous in society; and today in 2050, they are in our food, our medicines, and electronics. They are inside our bodies and brains, in our clothes, our homes, our roads and in most consumer products.

Although the sciences of creating and manipulating nano-particles at the atomic and molecular level was proven in laboratories decades earlier, the processes of commercialization of nano-technology were, in fact, the greatest challenge facing scientists and engineers, at least in the West. Several laboratories enabled turning the science from the laboratory into an efficient manufacturing environment. These included many national labs and the dozens of universities that they would partner with, taking advantage of one of the United States' major competitive advantages, world-class research universities and laboratories.

The standards for health and safety, however, have not been enforceable since products with illegal nano particles in them are everywhere. This has happened because most manufacturing organizations have little control over their supply chains. But, it also highlighted the situation between East and West, sometimes characterized as the West playing chess but the East playing Wei Qi or Go.

By implementing the U.S. Grand Strategy, capital investments by the government, industry and many venture capitalists enabled the country to remain number one in the global competition for nanotechnology market share. This has meant that many other countries have struggled just to keep themselves in the game, from China, Japan and Germany to smaller niche players such as Israel, Finland and Singapore. But, the strategy has been very successful for the United States.

Overall, the "Grand Strategy" looked at the many elements of the global nano ecosystem, all of which were identified and integrated into a whole. The strategy included ensuring proper funding for the nation's nanotechnology centers of excellence, such as those at the national labs. It also made a distinction between R&D funding decoupling the basic research and development equation thereby ameliorating many of the "valley of death" problems; the cash infusion associated with early capitalizations of new companies that frequently fails to last long enough to keep a company operating before the product is ready for the marketplace, and positive cash flow from actual sales can begin to really sustain the company long term. It happens all too often in start-up companies working on emerging technologies.

This ensured there was not only funding for basic research but also the "development" monies for design engineering, advanced engineering and advanced manufacturing commercialization efforts. By doing this, they could bridge the gap between pure science and commercialization so that nano laboratories could scale their work to create products useful for the many industries that were waiting for them. Since so much was at stake, the many Congressional committees and subcommittees involved agreed to work together to ensure the United States would win in the nanotechnology global marketplace. This required an understanding of the policy implications that could strengthen the economic component of national power; economic security, leading to improved national security.

In addition to the capital investments from the U.S. Treasury, there was a great deal of funding made available by U.S. companies and venture capitalists. Many corporations who were changing their product mixes did not want to be left behind and so they created nano departments within their R&D organizations to ensure their products benefitted from the emerging technologies as quickly as possible to beat out their competitors and be first to market.

The number of U.S. scientists, engineers, and academics publishing, giving conference papers and applying for patents soared whether those involved were from academia, government labs or the private sector. Many competitive advantages were gleaned, not only from the science itself, but from the process patents that protected how the scalability problems were solved in the commercialization efforts. Increasingly, some companies withdrew from the publication circuit to protect their intellectual assets from being copied by others, but the field continued to prosper in spite of a lack of sharing of some of the critical engineering physics, chemistry and biology capabilities and processes that enabled businesses to overcome the ever present "valley of death" syndrome.

The successful grand strategy and policy that the United States developed was based on the effective understanding of the complex systemic elements and their interdependencies; examining the social, technological, economic, environmental, and political elements and their interactions with one another as well as an examination of the boundaries of the system; understanding the basic science, engineering and manufacturing of the system and the stakeholders of the system.

Let's look at just one example,

The STEM educational system that created the intellectual capital of new nanotechnology scientists and engineers in the United States changed radically since the early days of the 21st century when the stove-piping of academic departments frequently would not permit scholars to engage in and develop many nanotechnology and other areas of research because they crossed disciplines. In the "publish or perish" world that narrowed the number and kinds of journal articles that led to tenure, this was a problem for many scientists who would not pursue the new areas of scientific inquiry between disciplines until they had tenure. The basic sciences were essential to protect, but the new sciences that were emerging needed to augment the old traditional ones. Both types of science were encouraged as legitimate paths to tenure. Academia was seriously incentivized through federal grants to experiment with inter- and trans-disciplinary science and engineering degrees directly to explore nanotechnology applications from community college programs to doctoral degrees.

At the same time, the debate in the country over the cost and relevancy of a college education lead many universities to create programs that students found useful in the real world.

What a difference this made; not only for nanotechnology, but for many other fields. Using science and knowledge to solve the real messy complex system problems of the world and making academia, perhaps. more "relevant" for the 21st Century has lead the United States into a new Renaissance age and has created a science and technology boom that is again the envy of the world. And, it occurred because the myriad Congressional committees that had oversight of the science were determined to give the United States the competitive advantage it needed to ensure economic security. With sequestration and economic austerity, it was becoming more and more obvious that economic security was an integral part of national security.

Now, what, you might ask, could possibly create the future I've just described in this era of political partisanship, bickering and general government gridlock – not to mention academic rigidity?

As a systems scientist and strategic futurist, I could give you hundreds of different pathways to where we could go as a society and how we might get there in spite of our current dysfunctions. But, most of them put the country into a major crisis – even an existential threat; cyber attacks, mass casualty pandemics, earth quakes, and so on. But, you are not my ordinary audience of Generals and Admirals. The point is do we need an existential threat to mobilize ourselves as a nation to develop a grand strategy? We have the capability and capacity to make this future a reality just like the men in that room in Japan in 1950. Taking a systems approach to the development of national policy may be the only way we will be successful.