Convergent Technologies and Future Strategic Security Threats

Today, serious security researchers who devote their energies assessing the realistic threats of 2025 and beyond may well consider revolutionary developments in future technology to have immediate or gradual military applications. These developments could contain leveraged and enhanced weapons that ultimately change the strategic balance through new missiles, satellites, lasers, and any number of new technologies which ramp up offensive capabilities or provide a strategic defensive edge. Beginning in the twentieth century, the advent of aviation, the tank, the missile, and the atomic bomb all provided in their own way evidence of progressively more sophisticated weaponry that conveyed genuine and substantial strategic advantage.

The linear development of newer weapons deserves as much attention as the darker dual-use characteristics emanating from any modern technology or advanced scientific discipline. But the chief challenge of the twenty-first century is to determine whether advanced technologies and breakthroughs in science will be largely benign and beneficial to society or will they inadvertently, or willfully, spawn entire groups of sinister future weapons we cannot yet imagine. If new, more dangerous, and strategically significant weapons emerge, it makes sense to ask a few basic questions, including: will future advanced weapons technologies remain in the hands of peaceful nations, will they be available to all nations, and will they be restricted or controlled in any way?

Global Security and Technological Convergence

We know the subject of technological convergence (TC) has arisen over the past 12 years, principally from a 2001 National Science Foundation (NSF) and Department of Commerce study which used the term extensively in its 2003 report, *Converging Technologies for Improving Human Performance*. In that case, the main focus was on using convergent technologies (CT) to advance the human condition in health, life sciences, education, and overall social well-being. Of course, there were considerable and impressive commercial benefits to be derived from CT,

and the report did delve into military aspects of the issue; however, the overwhelming emphasis was on human health and performance in a brand new century full of hope and optimism about harnessing new technologies to improve life and bring it closer to a more perfect state.[1]

What has largely escaped serious scrutiny and exhaustive research in the realm of security policy and military affairs is the net effect of CT on the global balance of power and the extent to which metatechnologies emerging from CT are developed into new weapons systems. Worse, there seems to be a lack of responsible analysis regarding how CT could alter asymmetric warfare.

The definition of *technological convergence* is a sensible starting point for the issues raised and the arguments about its strategic significance. Using a utilitarian definition, technological convergence is the tendency for different systems to eventually evolve, blend, and synergistically reinforce and interact with each other, sharing and extracting resources and energy to produce new and unique metatechnological products and outcomes.

It is precisely the future amalgamation, integration, deliberate blending, and synergistic transformation of discrete technologies into a multichimera-like dual-use metatechnology that has the potential to disrupt the global balance of power and alter our definition of asymmetric warfare. If we remain aloof and distracted by the myriad societal benefits and staggering achievements which could be derived from benign and beneficial advances in genomics, neuroscience, or cybernetics we will have missed a strategic shift at least as significant as aviation or the atomic bomb. The terrain which should hold our paramount interest is twofold. We must grasp the strategic significance of maturing metatechnologies in the fields of robotics, cybernetics, neuroscience, genomics, artificial intelligence, and nanoscience which culminate in products, achievements, and breakthroughs with dual-use properties. We must also reckon with the implications for inadvertent or deliberately engineered combinations, blends, and synergistic integration of these technologies which when combined display strategically significant dual-use properties. The degree to which these two parallel developments during the period 2013 to 2025 emerge as legitimate objects of study will make a critical difference to the United States for the remainder of the twenty-first century. For the sake of clarification, each technology below should be understood:

- *Genomics/proteomics/synthetic biology* entail all aspects of DNA-based systems design and engineered adaptation to enhance, enrich, hybridize, or create new life forms.
- *Cybernetics* and *artificial intelligence* refer to progressively complex engineered computer systems integrated with information systems and databases to bridge the man-machine interface, thereby making both machines and man more capable of complex thought, independent assessment, and analysis which neither could attain by itself.
- *Neuroscience* refers to the broad group of scientific and technological methods, systems, and structural pathways which involve manipulation and enhancement of major brain functions such as thought, perception, judgment, mood, and behavior.
- *Nanoscience* refers to the subatomic level of materials where design, structure manipulation, and combinations of basic molecules below the ordinary molecular level enable development, hybridization, and creation of wholly new structural machines and submicroscopic systems.
- *Robotics* refers to the entire class of engineered and designed automatons which mimic human shapes and dimensions and rely on cybernetic subsystems enhanced with advanced electronics but which display and enact behaviors, actions, and maneuvers at a level of depth, complexity, and accuracy that rivals or exceeds what ordinary humans can do.

Convergent Technologies—What Does It All Mean?

We have seen the growth of space research and the degree to which its national security aspects dwell alongside the global quest for more and better information about the universe and its reciprocal impacts on our earthly society. No doubt, discoveries and revelations will emerge from this field, but unlike the areas of CT mentioned so far, space provides significant and daunting limitations and constraints on what can be discovered and achieved. Without doubt the steady growth and development of CT will be revolutionary in scope with the potential to radically change industrial, economic, and social structures in the twenty-first

century. It is abundantly clear CT activities such as bioinformatics, DNA diagnostics, molecular electronics, and neural computation are revolutionizing the traditional interaction between researchers, industry, and society. New models for research management are evolving based upon networks which break down the barriers between traditional disciplines

Among other things, this means both a cross-disciplinary and transdisciplinary array of interactions, collaborations, and exchanges will take place over the next decade. Genomics and neuroscience will combine, cyber systems and artificial intelligence will collaborate, and robotics and nanobiological research will merge over the course of the next 10 years. While there is currently no serious public debate about CT, it must be seen in this context. It has, and will continue to be, relentlessly driven primarily by research policy actors, foundation funding, and by experts from various disciplines and is part of a more comprehensive political and social discourse on nanotechnology, biotechnology, information and communications technology (ICT), brain research, artificial intelligence (AI), robotics, and the sciences that deal with these topics.

Obviously, the government has an interest in CT and will undoubtedly nurture as many aspects of the separate key technologies as possible to foster their individual lanes of growth toward maturity and a state of metatechnology. It is far less clear what the world's other advanced nations will be doing while the United States alternately infuses and deflates continuing research and development activities in these separate but strategic areas. Convergence will likely be welcomed and supported in the European Union (EU) and Russia, as well as Asia, and the oversight, direction, and trajectory of each distinct technology will be shaped and guided by experts, investors, leaders of global enterprise, and academics while the audience of interested states contemplates how each technology might conceivably convey some unknown or unexpected form of strategic leverage. It also appears likely the EU, Russia, and Asia may want to follow a very different path than that of the United States, and for good reason. Make no mistake; the key question tied to the strategic significance of CT is one that does not reside solely inside the ambit of US security thinking. Nor is it subject to US control, protection, or governance.

Whether an international consensus on CT should be derived prior to, or after, a national security decision which elevates this area as a strategic benchmark for the twenty-first century remains to be seen. It

is within reason, and expectation that the EU, Russia, and Asia will want to put their own stamp on the development, control, and evolution of CT. If this is the case, whither the US strategic posture on CT itself? Some pundits would put the dead reckoning with CT far off and argue that we need not concern ourselves with its eventual maturation for another 25 years. This is more risk-management and gambling than serious strategic analysis.

Maybe the degree of public interest and congressional clamoring, together with the desultory drumbeat of the media, is insufficient to awaken US strategic thinkers to address CT issues. Perhaps they feel it is too soon to even formulate the question, as there are so many other pressing national security issues like Afghanistan, sequestration, immigration, trade, terrorism, loose nukes, Syria, and transnational organized crime. Evidently, this array of security issues is strong enough to drown out sustained discussion of CT for the time being.

Perhaps some would diminish or belittle the subtle threats which emanate from each discrete technology until that particular technology has been developed to a state of near perfection where all manifestations of its dual-use nature become apparent. For others this still falls short of caution, because the nefarious and negative side of dual use is seen as minimally dangerous if at all.

With this initial array of discrete but largely parallel technologies, it is enough to posit dual-use systems arising from their separate lanes of near perfection that could display patterns of behavior and actions which either enhance existing weapons or create new ones. Cybernetics and robotics could lead to a new warrior class of supra-human fighters against which conventional arms would be useless. Neuroscience and nanoscience could combine with genomics and create nanoscale aerial invaders which could inhabit our brains and remotely influence or direct our thoughts. As far as the most advanced researchers in each field are concerned, they uniformly claim there is no limit to the upwardly sophisticated actions and tasks which their field of technology can accomplish. They may disagree on how long it would take or how easy blending different technologies would be, but few are saying it is impossible to attain. Sounding the alarm about this impending watershed era in weaponization and over-the-horizon strategic threats is crucial. To argue against the likelihood and probability of this outcome is akin to saying every low-probability/high-consequence threat never merits serious

policy attention. History has sadly shown that such threats are understood only after they have unleashed chaos and mortal damage. Over the next 15 years, risking that these emerging technologies by themselves amount to nothing more than substrategic threats is to seriously misunderstand the nature of the threat itself.

Do We Grasp the Strategic Threat?

Maybe CT is understood to be largely benign, controllable, and ultimately governable, with the net result that strategic thinkers have dismissed the inherent risks embedded in CT as well as the strategic significance of dual-use matured metatechnologies. Perhaps this has been quietly studied at the classified level and found devoid of strategic significance because no one knows or can guess where each of the discreet technologies will be 10 years from now.

There is also a legitimate argument to be made that CT is not in public parlance and receives no serious media attention because open discussion of advanced science and technology has been constrained to a limited audience of academics, inventors, and scientists. One reason for this may well be the fact that CT itself has been inadequately clarified and is simply too ambiguous for anyone to generate concrete questions or ascertain its dimensions. It does not appear to trigger serious political or scientific debate, which therefore further constrains efforts to clarify the concept or make it more concrete in relation to clearly delineated areas of research and potential applications.

We must stop and assess the nature and scope of the issue, particularly if we argue that it is indeed a future threat. Ever since the 2003 NSF-Commerce report was first issued, there have been periodic discussions of CT in the media, and it has captured the attention and imagination of a few influential observers. The tone is understandably euphoric about the great achievements which could result. As cited in the report, futurist Ray Kurzweil predicted the arrival of *singularity*, which he defines in his book on the subject as "the culmination of the merger of our biological thinking and existence with our technology, resulting in a world that is still human but that transcends our biological roots." He writes, "There will be no distinction, post-Singularity, between human and machine or between physical and virtual reality."[2]

Kurzweil also predicts a second revolution in the area of nanotechnology by 2020. According to his calculations, it is already showing signs of exponential growth as scientists begin to test first-generation nanobots that can cure some diseases and injuries. "Nanotechnology will not just be used to reprogram but to transcend biology and go beyond its limitations by merging with non-biological systems," Kurzweil says. "If we rebuild biological systems with nanotechnology, we can go beyond its limits."[3] The final revolution leading to the advent of singularity will be the creation of artificial intelligence, or super intelligence, which could be capable of solving many of our biggest threats such as environmental destruction, poverty, and disease, according to Kurzweil.

However, it seems obvious distinctions that separate scientific disciplines will break down, as advances in one field enable new thinking in others. Moreover, Dr. James Canton claims in the NSF report, "This new holistic model will combine advances in four different fields—nanotechnology, biotechnology, information technology, and cognitive science (known collectively as NBIC)—to achieve "a golden age that [will] be an epochal turning point in human history." With all this attention devoted to the spirit of human cooperation and the symbiotic global harmony that will characterize the future of the sciences some were so idealistic as to presume that one day, "Technological convergence could become the framework for human convergence—the twenty-first century could end in world peace, universal prosperity, and evolution to a higher level of compassion and accomplishment."[4] Concerns about manipulation of the brain, thought patterns, emotions, and perceptions seemed overwhelmed by grand pipedreams about making our brains smarter and more durable.

Finally, while the 2003 report proposes a national R&D initiative to bring this convergent future into being, the national security aspects of CT were ignored or underplayed. The central message was to promote CT wherever possible in the new twenty-first century along with broad NBIC injections and support inside the American education system—all this without much fanfare about the dual-use nature of CT, what the spinoffs of matured metatechnologies could mean in strategic terms, or whether the possession of CT by a prosperous peaceful nation mattered as much as whether it became part of the Iranian or North Korean arsenal.

The earliest CT initiative dealt with bioethical issues. This was partly due to the fact that the President's Council on Bioethics, which is generally considered to represent conservative values, criticized it. The focus of this

criticism was the close linking of the CT conception of this so-called NBIC initiative with visions of far-reaching human enhancement—a technological modification of the human body and an ongoing merging of the human mind with machines. During the same period, elements of the NBIC initiative attempted an awkward alliance with trans-humanists who sought to promote human perfection and progressively technical modification of the human body through applied technology. Among their beliefs were the use of hallucinogenic drugs and the elimination of human death by resorting to science and technology. It is especially these particular features of the initiative that led the CT debate to exhibit such an extremely visionary character and to focus on the topic of human enhancement. Another bizarre interest of the trans-humanists was to eventually create cyborgs that were cognitively superior to humans.

This is simply to overstate the obvious—thousands of intriguing distractions, discoveries, and breakthroughs will eventually emerge from each aggregate subtechnologies discussed. But without serious and sustained discussion of the national security issues and aspects of CT and the ultimate ripening of metatechnologies, we will miss a crucial milestone in human history. There is a real danger that scientific achievements and discoveries will attract more attention and merit more public discussion than the wide array of security questions embedded in CT itself.

Is that because we fail to grasp what CT really is—or is it something more subtle and complex? If we are fortunate enough to master the evolution and maturation of metatechnologies and collaboratively manage and control the growth of CT, then concerns about neglected security issues will evaporate. However, nothing relieves the United States from the need to develop a strategic perspective on international commerce and trade involving CT or assessing the degree to which CT emerges as a bona fide weapon system in the EU, Russia, Asia, and among designated enemies. The opportunity to assess its true meaning and long-term strategic significance is now, and it deserves top priority among Pentagon and national security experts.

Summary

To remain passive and await emerging news and progressively more-sophisticated developments and outcomes from these discrete areas of science and technology which exhibit societal benefits is to shun the use

of coherent and comprehensive strategic analysis for the next decade. The principal argument is the imperative to begin paying serious strategic attention right now to CT or risk suffering some form of global security erosion detrimental to US interests. The areas of specific focus include genomics, synthetic biology, biomimetics, virtual reality applications for biological systems, nanobiotechnology and nanomedicine, artificial intelligence, nanoelectronics, nanophotonics, cybernetics, robotics, neuroscience, and the fields of simulations and modeling. It is a fair estimate that by the year 2023, major elements of CT integration and deliberate blending will have already occurred and considerable experimentation will have taken place. Regrettably, we lack the policy, doctrine, and strategy to address this event.

If we fail to study and examine the immediate and long-term implications of these complex dual-use areas of legitimate scientific inquiry, along with the related technologies they promote, we will have suffered a serious lapse in our national security that will be extremely difficult to overcome. Our nation's security and our national well-being require that we make the CT issue a top strategic priority for the twenty-first century.

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Notes

1. Mihail C. Roco and William Sims Bainbridge, eds., *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science* (Washington: National Science Foundation and Department of Commerce, 2003).
2. Lara Farrar, "Scientists: Humans and Machines Will Merge in Future," CNN.com, 15 July 2008, http://www.cnn.com/2008/TECH/07/15/bio.tech/index.html. See also, Ray Kurzweil, *The Singularity Is Near: When Humans Transcend Biology* (New York: Penguin Group, 2005).
3. Farrar, "Scientists."
4. Quoted in "Carried Away with Convergence," *The New Atlantis* no. 2 (Summer 2003): 103.