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The NBRIC Revolution and International Relations?

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Key Points

- The rapid advancement and application of Nanotechnology, Biotechnology, Robotics, and Information and Communications technology (NBRICs) raise many questions regarding human evolution, regime sustainability, the context of contemporary and future conflict and cooperation, as well as the nature of power and its distribution in the international system.
- NBRIC technologies can generate new strategic challenges and sources of insecurity, enable a broader range of actors to address those challenges, and aid the design and implementation of strategic responses.
- Their application can lower the human and political costs of war and pose challenges for arms control. As a result, such technologies will increasingly shape state and institutional strategic cultures.
- Such technologies give rise to the notion of "cognitive power" and raise the possibility of global elites able to navigate the dense information networks and the disenfranchised remainder who may strike back through radical and super-nationalistic narratives.

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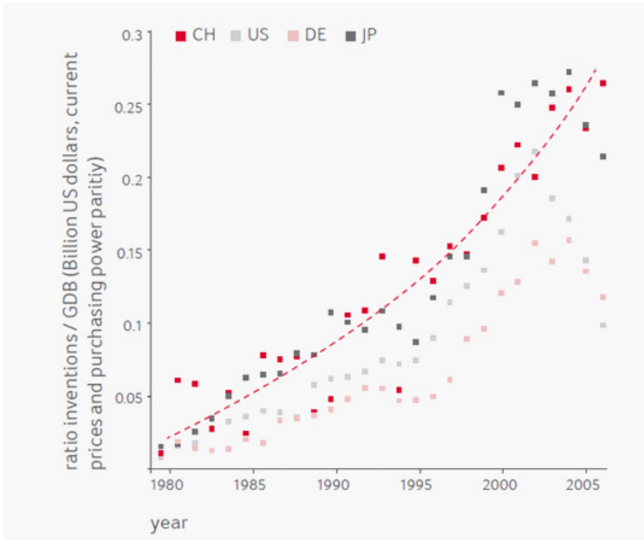
We live in the "Anthropocene" era – the Age of Humans: human activity impacts earth's atmosphere, its climate system, and is the driver of one of the biggest mass extinctions in history.[1] The rapid advancement and application of NBRIC technologies (Nanotechnology, Biotechnology, Robotics, and Information and Communications technology) both enable and exacerbate the global impact of human activity. The rise in speed and fall in the cost of computational analysis and the force multiplying convergence of NBRIC clusters have led revolutions in these inter-enabling technologies. Such technologies are located in biological systems where biotechnology and genetics, post-genomics, and epigenetics try and bridge the gulf between the genome and the organism, and material systems, where advances in nanotechnology, robotics and information and communications technologies are ground-breaking.

The NBRIC revolution raises many questions with regards to human evolution and behavior, regime-types and their sustainability, the context of contemporary and future conflict and cooperation, as well as the nature of power and its distribution. NBRIC technologies present us with a complexity that neither existing intellectual tools nor established language is adequate to address and that we are only beginning to identify and understand.[2] What might be the impact of the NBRIC revolution in International Relations (IR)?[3]

NBRIC Technologies: Definitions

Nanotechnology (NT) is the manipulation and manufacturing of matter on atomic and molecular scales. NT takes advantage of new approaches to molecular physics and assembly tactics, and its applications cover disparate fields such as medicine and drug delivery, material science, and the weapons industry; it is on the cusp of becoming the dominant general purpose technology of our time. Biotechnology encompasses fields related to applied biology, and its applications are far-reaching and wide-ranging. Obvious disciplines include medicine, pharmacology and related healthcare fields, and are joined by agriculture, genomics, cloning, biofuel, and among countless others, NT and weaponry. Though not as recent a domain, robotics is making equally exponential strides. From the assembly lines in Detroit and Japan to the bleeding-edge research in universities and hospitals, robots are ubiquitous in the modern world. New research is focused on combat and warfare robots and the ethics therein, artificial intelligence (AI), and a deepening potential for organism-robot interface. Finally, information and communication technology (ICT) is arguably the glue of not only NBRIC technologies, but the flattened, interconnected world as we know it. Anne-Marie Slaughter, Director of Policy Planning for the US State Department, has noted that, "In this world, the measure of power is connectedness".[4] ICT innovations shorten distances and allow collaboration beyond what many previously thought imaginable. From finance to intelligence gathering to recreation, these technologies allow people to interact in real-time from almost anywhere on the globe to anyone, all the time.

Interrelated technologies that undergo simultaneous, mutually reinforcing parallel growth have always historically carried with them institutional, organizational, economic, cultural and political change, undermining cultural constructs and institutional systems that appear solid and enduring. The most important aspect of NBRIC technologies, however, is not their standalone potential. It is their inter-enabling nature – NT will further enable biotechnological applications and robotics, robotics and AI will further enable nano-manufacturing and biotechnology, and ICT will enable information sharing not only among researchers, state officials and military personnel but among the units of NBRIC themselves. If Moore's Law (which describes, among other things, the tendency of processing power to double every two years) holds true into the coming decades, then the NBRIC revolution and subsequent applications will grow faster than our ability to legislate or regulate these new technologies. In all likelihood, however, Moore's Law will be surpassed and as the clusters grow, each will augment the startling growth of the others, at even higher exponential rates.



Number of nanotechnology-related inventions which were filed for patent protection.
Source: *Swiss Nanotech Report 2010*.

From Human to Trans-Human and Post-Human Futures?

How will the application of genetic engineering and biotech implants shape the future evolution not just of human behaviour, but the notion of what it is to be human itself? Components of biological systems that do not naturally exist can be constructed and designed through technically-modified cybernetics (allowing man-machine interface, called humonics), as well as the manipulation of DNA through the use of synthetic biology and NT. Our understanding of the potential use and abuse of NBRIC technologies demonstrates that our ideas, narratives and perceptions of NBRICs can matter as much as the technologies themselves.[5] Analysts chart potential promises and perils across the spectrum, from life-enhancing to soul-destroying effects and implications.

The application of such technologies can enhance human capabilities and performance, so overcoming innate and fundamental human physical and cognitive limitations. In this liberating *Prometheus Unbound* scenario, humans could create, engineer and lengthen life to become healthier and disease- and disability-free. Such technologies can increase food production and so address malnutrition, maternal mortality, poverty, exclusion and the attainment of other UN Millennium Development Goals. Similarly, biotech and synthetic biology could create algae that suck up carbon-dioxide and excrete hydro-carbons, allow for faster vaccine production and purify water. These technologies allow us the possibility to evolve from our current homeostatic human existence to reflexive trans-human life where, ultimately, "functional human immortality" is achieved as biotech advances allow for the uploading of human consciousness into information networks.[6]

Box: Our Final Century?

"Science is advancing faster than ever, and on a broader front: bio-, cyber- and nanotechnology all offer exhilarating prospects; so does the exploration of space. But there is a dark side: new science can have unintended consequences; it empowers individuals to perpetrate acts of megaterror; even innocent errors could be catastrophic. The 'downside' from twenty-first century technology could be graver and more intractable than the threat of nuclear devastation that we have faced for decades. And human-induced pressures on the global environment may engender higher risks than the age-old hazards of earthquakes, eruptions, and asteroid impacts".
M. Rees, *Our Final Century: Will Civilisation Survive the Twenty-First Century?*, London, Heinemann, 2003, p. vi.

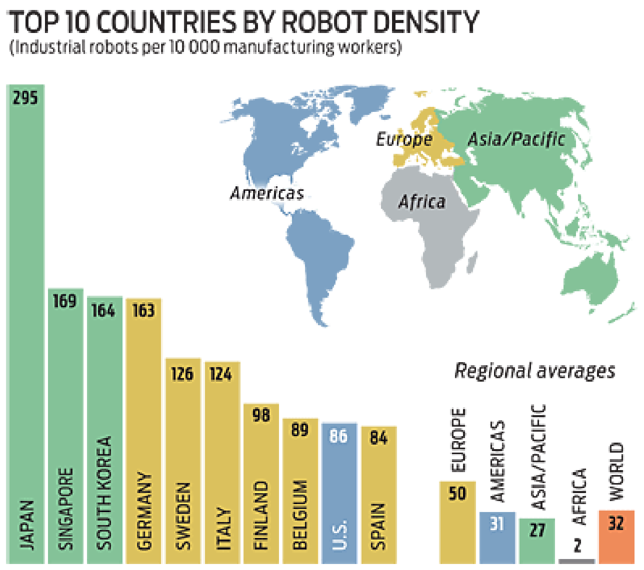
However, this technology is also viewed as potentially disruptive. In *Our Posthuman Future*, Francis Fukuyama raises the prospect of genetic drift within the human species, destroying biological equality upon which human rights are based.[7] He posits that at present, NBRIC technologies are high risk, profit-driven, poorly governed sectors that could destabilize the human genome, erode interspecies boundaries and ultimately, dehumanize and destroy humans. A "Terminator Scenario" is conjured in cinema and literature, a world in which *Homo sapiens* constitute an inferior sub-species to be enslaved, slaughtered or contained by post-human sentient machines. But "default" options are equally bleak: "slippery slope" scenarios include the possibility of individuals controlling their own genetic mutations ("bioengineering in the kitchen") and unintentionally generating uncontrollable consequences. NT in particular carries with it many concerns about human health and toxicity risks coupled with unknowable environmental impacts.[8]

Of BRICs and NBRICs

The expectation of future change modifying contemporary state behaviour is referred to as the "shadow of the future". One particular shadow is the expectation of power redistribution from the US and Europe to Brazil, Russia, India, and China (the BRIC states) – fast growing developing countries, which were predicted in 2003 to form a powerful economic grouping that would surpass the share of global GDP of the G-6 by 2050, if not sooner.[9] Goldman Sachs also highlighted the potential of the next echelon of states to become this century's largest economies, coining the acronym Next-Eleven (or N-11 states).[10] The status of "emerging power" represents an acknowledgement and recognition that high economic growth and large and growing populations are central to such an identity. While traditional measures of state power include the size of GNP, territory, population, armed forces, and lack of strategic vulnerabilities, in this century "economic concerns typically – but not always – outweigh traditional military imperatives".[11] The question then arises, how might the application of NBRIC technologies shape economic growth and the cultural attractiveness of ascending powers? Intellectual capital, particularly scientific and technical knowledge critical to the creation of NBRIC applications can also be a measure of power.

There is an implicit notion that markets, companies, currencies and finally countries emerge and that a trajectory or evolution from "poor developing" to "rich developing" to "rich developed" state status can be charted. A hierarchy is implied, with some states in front, others behind and some in the middle. As states evolve along this continuum, a measure of their power is their ability to obtain preferred policy outcomes. These countries emerge as challengers and counterweights to G-8 countries, able to exercise representational power within their regions. Ultimately, as power is relative, their emergence challenges American "primacy", that is the US's role as the "prime player" in the international system, one that is able to set the rules of the game due to possession of unprecedented strength and power. As a result, the global strategic landscape is remodeled – power shifts recalibrate intra-Great Power relations, as well as relations between Great Powers and the rest.

To address these questions we must identify which states possess the capacity to acquire NBRIC applications and which have barriers. The answer is a function of size, composition and quality scientific and technological base, as well as "their institutional, human, and physical capacity required to develop drivers for, and overcome barriers to, implementing technology applications".[12] According to a RAND report, the location of scientific and technological complexes essentially reflects traditional measurements of power capabilities: scientifically advanced countries are located in North America, Europe and Asia; China and India are fast rising technological powers; there is "wide variation in technological capability among the scientifically developing countries of Southeast Asia and Latin America"; and the largest gap exists between "most of the countries of Africa, the Middle East, and Oceania and the rest of the world".[13] If we take industrial robotic density as one crude metric to test this contention, we find that Japan has 295 robots for every 10,000 manufacturing workers (almost 10 times the world average), while Singapore has 169, South Korea 164, and Germany 163.[14]



Source: E. Guizzo, "The Rise of the Machines", *IEEE Spectrum*, December 2008, illustration by Mike Vella http://spectrum.ieee.org/robotics/industrial-robots/the-rise-of-the-machines/0

Will this scientific and technological power distribution hold for the future? Or might innovation breakthroughs in specific areas have a game-changing potential, enabling third and fourth-tier states from or beneath the Next-11 category to gain strategic advantages and so more easily obtain preferred outcomes compared to, for example, the BRICs? Do possession and exploitation of such technologies generate a cognitive power over competitors?

Soft and Hard NBRIC Power

NBRIC can be understood as providing tools that can generate and reinforce cooperative efforts between states. Indeed, the need to govern these emerging and converging technologies themselves provide opportunities for inclusive, multi-stakeholder and transparent global governance approaches.[15] The example of WikiLeaks might be evidenced in support of the power civil society actors have to use confidential but easily dispersed information via ICT to render governments more transparent and accountable.

One key driver of the NBRIC revolution is the desire of states to modernise their hard power capabilities to be able to secure national interests. The amount of state economic and human resources spent on military research and development is therefore one indicator of future hard power potential. If we examine US spending on NT, we can see that it jumped from approximately $464 million in 2001 to $1.5 billion in 2009, far outstripping peer competitors.[16] One third of American NT spending is on military research and development, creating the vision of "nano-enabled supersoldiers fighting on nanotech battlefields".[17]

The uses of military robotic technology are highly varied, from the UK's Dragon Runner[18] bomb disposal robot to South Korea's armed robotic sentries guarding the De-Militarized Zone.[19] Advances in artificial intelligence allow for the possibility of enhanced mobile autonomous robots in battlefield environments. DARPA, the US Pentagon's military research branch, held the development of an advanced AI as "the overarching goal of their Biologically Inspired Cognitive Architectures, or BICA, program, which sought to mimic the physiological and neurological elements of the human mind".[20] Major advances in AI and autonomous robotic battlefield systems predicted over the coming decades will allow states to project their power using assets that have key advantage over human analogs: "They don't get hungry. They're not afraid. They don't forget their orders".[21] As the human and political costs of war decrease, the barriers to waging war may well be lowered.[22] NBRIC technologies will play an increasing role in shaping if not yet determining state and institutional strategic cultures: that is, where, when, how and why coercive force is used for political objectives.

As our knowledge of genetics, epigenetics, and gene therapies deepens, the implications for the stability and potential extension of existing chemical and biological arms control regimes are profound, with the real danger that the discovery of new biological and chemical weapons could outpace the scope of the international community's ability to regulate. Could "genetic genocide" become a possibility as the exploitation of genetic differences enables the generation of a potential biological weapon of mass destruction? Conventional arms control regimes will also be challenged. It is clear that the "density and effectiveness of military forces cannot be measured simply 'in numbers of tanks and fighter aircraft', but that other categories such as cruise missiles, UAVs and perhaps other robotic systems or autonomous vehicles will have to be included".[23]

Finally, ICT has an important and ever-growing role to play in political and military operations. Improving shared situational awareness and direct connectivity and coordination in complex military operations are the main goals of Network Centric Operations (NCO). The strengths of NCO rely on asymmetric technological capabilities. But as off-the-shelf products begin to catch up with military technology, state-sponsored NCO may no longer be as powerful an asset. There is cause for concern that NCO operations may be leaked to non-state actors, or possibly even conducted by non-state actors themselves: "sophisticated hacking tools are widely available on the internet" and black hat hackers often auction off their skills or are enlisted by non-state forces such as Hezbollah and al Qaeda.[24]

Conclusions: Towards an NBRIC Revolution in IR?

This paper has examined the relationship between NBRIC technologies and IR. NBRIC technologies will impact IR in ways in which we can only speculate, and which do not yet constitute a revolution, though state, societal and individual actors are all challenged. Might we argue that just as the primary organizational structure of the 20th century was state-based linear hierarchy, the 21st century organizational structure will be more decentralized and non-linear, a flattening world of complex networks? Will such a new world order paradigm be cooperative or conflictual?

At the state level, who can benefit the most from such technologies, and who the least? We might hypothesize that more open and democratic regimes prove better at basic research into NBRIC technologies while more authoritarian regimes will show a greater ability to mobilize resources to then exploit and develop their applications. At the societal level, we can ask whether NBRICs create winners and losers, and whether these largely replicate existing elites and disadvantaged under-classes within states. Or is the existing order turned upside down, with a new global technocratic and scientific transnational elite, located in technological clusters and hubs? "Is not the current prospect rather one of a constellation of territories, large metropoles and special zones linked together via information and communication networks"?[25]

Here we might envisage a world in which global elites that can navigate the dense information networks are in opposition to the disenfranchised remainders, those that "are incapable of keeping pace with continuing change; unable to integrate into the information webs that increasingly define human cognition; and aghast at the changes in lifestyle, income distribution, relative power relationships, and changes in sexual and family roles and structures that have resulted".[26] Such groups may then decide to strike back through radical fundamentalist and super-nationalistic narratives and actions.

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