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From Nanotechnology to Nano-Defense

Will nanotechnology impact future global security? According to Jayshree Pandya, such technology is indeed about to change large-scale security dynamics, defense policies and possibly even the global balance of power.

By Jayshree Pandya for ISN

Editor's Note: Last week, the ISN's Peter Faber described how the once-dominant Napoleonic-Industrial way of war has strained to cope with the messy hybrid wars of the present. These wars, in turn, have changed our reasons for relying on 'hard power'. Their purpose today, at least in part, is to 1) win over the hearts and minds of noncombatants, or 2) create the 'strategic space' needed to obtain desired ends, preferably by other means. In order to accomplish these ends, today's armed forces are restlessly looking for new tools and methods to cope with 'non-obvious' wars. In trying to clarify this quest, this week we will look at how it is evolving.

Among the issues we will cover are the role and impact of nanotechnology on future security; our increased reliance on Unmanned Aerial Vehicles (UAVs) and autonomous military platforms; the future role of robots in conflicts and how they might be governed; the growing prevalence of remote, from-a-distance warfare; and the 'weaponizing' of the law in modern disputes. To start the process, in today's special feature Jayshree Pandya highlights some of the advantages and risks that nanotechnology does (and will) bring to global security.

The global age has heralded both beginnings and ends. The end of states living in isolation has been accompanied by the beginning of an interconnected world and interdependent global economy. In addition to changing global fundamentals, the emerging potential of science to engineer matter at nano-scale levels is decisively paving the way for a revolution in the way states fight wars. Accordingly, as nano-science, engineering and technology begin to transform the global defense industry, it is vital to redefine security and war and evaluate the current and future state of militaries and international security.

All states are eager to benefit from nanoscience, nano-engineering and nanotechnology initiatives – either directly or indirectly. While most states do not yet have dedicated nano-defense initiatives, rapid advances within the aforementioned fields are exciting many and becoming a cause of concern for the rest. In short, nanotechnology has the potential to be revolutionary. Yet, its ongoing development is accompanied by critical risks that need to be addressed and effectively managed. It is a great cause for concern that there is no credible initiative for integrated research on emerging nano-defense risks.

The Emergence of Nano-Defense

In addition to the fundamentals of basic science, the advanced ability to engineer matter to nano-scale continues to make nanotechnology possible today. As states move away from basic nanoscience research towards application development, it is expected to bring revolutionary changes for not only defense, but also other industries and society in general. This unique possibility to integrate science disciplines is likely to bring states “nano” everything . Moreover, possible nano integrations are expected to not only change the fundamentals of basic industries, but also the way a nation fight wars.

It is this nano integration possibility – integration and convergence of nanotechnology and basic industries – that provides states with opportunities to develop technologies with huge unique potential. From revolutions in materials, communication technology, genetics, medicine, and security, the integration is expected to roll out innovative visualization and measurement tools, materials, transistors and energy sources, to name but a few.

Military Applications

Nano-science, nano-engineering and nano-technology are expected to play a significant role in the changing nature of security and defense across states. While the fundamentals of nano-scale engineering are in the process of optimization, how we fight wars and safeguard society are also expected to go through fundamental transformation in the coming years.

The on-going integration of nanotechnology and defense into nano-defense is expected to bring innovations in broad, wide-ranging areas that will revolutionize militaries and play a critical role in maintaining national security. While some are already using nanotechnology applications in the military – in the form of nano-particles used as surface coatings, nano-materials and structures, nano-fabrication, and more – that give them much-needed abilities, the coming years will bring transforming abilities that will go beyond current capabilities and human imagination.

For instance, modern armed and security forces will eventually be able to:

- Detoxify an area exposed to toxins
- Detect the onset of disease in an area exposed to biological agents, toxins or radioactive material
- Secure electronic, information, and communication networks
- Protect human lives and troops through nano-fabrics and related materials
- Spy and gather intelligence

In the coming years, nanoscience, nano-engineering and nanotechnology will also bring to reality:

- Fundamental improvements in human performance
- Lighter, efficient, and effective military gear
- Nano-robots and micro-robots for nano-scale devices and systems
- Novel biological weapons, ranging from nano-bombs and nano-engineered self-multiplying deadly viruses to bombs that use nano-metals and next generation bio-weapons
- Smart weapons for miniaturized robotic weapons

- Intelligent ammunition for intelligent nano-bugs
- Meta-materials based invisibility suits for nanostructure-based lighter and tougher armor
- Adaptive sensors, built-in sensors, and micro-sensors for body and brain sensing to nano-sensors
- Virtual tracking systems for nano-information hardware

Accordingly, nanotechnology offers a number of wide-ranging possibilities, thereby making it an appealing investment for developed and developing states alike. This is expected to be of great concern across traditional industries that may see nanotechnology compromise their investment appeal and potential. Overall, greater interest in nanotechnology investment will create shifting investments and may lead to job losses across traditional industries.

Impact on International Security

Conversely, emerging nano-defense capabilities place the fundamental ability of governments to protect its citizens, resources, and infrastructure at risk. While nano-defense applications are currently in limited use, the expected advances in the coming years will likely provide military and defense organizations better protection. For the war fighter, nano-defense capabilities may provide greater endurance and, crucially, information dominance.

Nano-defense will, therefore, have a profound impact upon international security. Increased public spending and investment in nanotechnology is likely to result in defense establishments and actors experiencing a fundamental transformation in the coming years. Consequently, it is now time to evaluate how nanotechnology will shape and transform a nation's defense systems, and ask whether traditional militaries are prepared to face the impact of nano-military and nano-defense. The questions every nation needs to evaluate are:

- How rapidly will nanotechnology displace traditional defense systems?
- What will be the trigger points of a nano-defense crisis?
- What is the strategy to communicate critical nano-defense risks?
- Is a nation prepared for the possible collapse of traditional defense systems due to nano-defense?
- Is there a possibility of collapse of social order due to sudden shift in economic and military status?
- How will the emerging nano-defense and possible collapse of traditional defense systems impact upon a state's relationship with the global community?

The above-mentioned questions necessitate an evaluation of the complex problems, obstacles and challenges that nano-science, engineering and technology may bring not only to defense and security establishments, but also to states. This is also required to determine what a state already knows about nanotechnology and, indeed, what they need to know in order to address the potential threat posed by emerging nano-defense capabilities.

Emerging Risks

Billions of dollars are being invested for research and development within nanoscience and nanotechnology. As a result, intense competition will emerge in the coming years as states are bound to see an increase in products and applications for military and defense. Across states, this is a cause

for critical concern. As a result, states will need to evaluate some (if not all) of these and other emerging risks:

- Nano-Manufacturing Risks: there is a growing concern that nano-manufacturing may prove to be disruptive for an already weak global economic system and fragile global peace.
- Nano-Environment Risks: whereby the large-scale use of nano products may trigger potential environmental challenges.
- Nano-Terrorism Risks: potential nanotechnology-based military weapons carry the risk of being illegally acquired and used by terrorists, bringing serious threats to not only individual states, but to global peace.
- Nano-Military Risks: for example, one future scenario sketches self-replicating robots that may trigger a global arms race with nano-weapons
- Economic Risks: these consider the impact of sudden, rapid and destabilizing changes due to nanotechnology.
- Regulatory Risks: as nanotechnologies develop, problems may emerge as a result of the lack of a global nano-defense regulatory framework.
- Resource Risks: nano-computers and nano-electronics may eliminate the role of humans from the battlefield, bringing a dramatic shift to military needs and resources.

Accordingly, as the world moves ever closer to nano-defense, this shift is causing a great source of concern on the basis that fundamental risks surrounding nanoparticles are yet to be fully understood. While there is an ongoing effort to understand human health and the environmental risks of nanoparticles and nanotechnology, its silo approach to risk assessment is a cause of critical concern to the risk initiative itself. Rather, an integrated risk initiative is needed to evaluate nanoparticles: mode of entry, interaction with human body organs, impact on vital human organs, evaluation of current tools, techniques and procedures, ecological degradability, impact on the global food supply chain, litter waste disposal, metabolism and elimination from human body, and role in the non-communicable disease epidemic.

In addition, a vital question that is critical for nations to evaluate is whether nanotechnology may potentially reverse globalization. The potential to bring abrupt and sudden changes across traditional industries, national and international boundaries and global trends could trigger socio-economic disruption and the decline of the state.

Amidst a global race of acquiring novel warfare solutions, the most powerful states are likely to have military, defense, war and security solutions based on emerging technologies like nanotechnology. It is likely that nano-defense may end up becoming one of the key determining factors for a state's success, abundance, and global power.

Jayshree Pandya (née Bhatt) is the founder of Risk Group LLC (<http://www.riskgroupllc.com>), a risk research think tank organization that focuses on risk centric critical thinking and objective evaluation of nations, their governments, industries, organizations, and academia (NGIOA). She is the author of [*The Global Age: NGIOA @ Risk*](#), published by Springer in 2012.

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ISN, Center for Security Studies (CSS), ETH Zurich, Switzerland