

Use nanotechnology for Safety by Design

Current trends in nanotechnology, ICT, privacy and security

Interview with Prof. Dr. Ashok Vaseashta, NUARI, USA

Ineke Malsch, postbus@malsch.demon.nl interview 26 November 2010, published 6 December 2010

Abstract

Ashok Vaseashta is Director of the Institutes of Advanced Sciences Convergence and International Clean Water and has several other scientific and policy-advising assignments. His research interests include chemical and biological sensors, counter-terrorism, water safety & security, environmental pollution monitoring & remediation and green nanotechnology. He proposes to use TechFARM (Technology Foresight, Assessment and Roadmapping) for mapping trends in converging technologies (Nano, Bio, Info, Cogno). Ultimately, his aim is to let nanotechnology contribute to safety by design of new products and technological systems.

Under the header of Nanotechnology, ICT, privacy and security, ObservatoryNano aims to highlight technological and economic trends in nanotechnology for ICT and security applications with potential ethical and social implications. Simultaneously, current debates on relevant issues in nanobioethics among ethicists and social scientists, policy making circles and stakeholders are analysed and confronted with the issues emerging from the technical and economic trends. This way, emerging issues not discussed sufficiently can be identified and brought to the attention of policy makers in the third annual report on nanotechnology, ICT, privacy and security to be published online in the spring of 2011. The series of interviews with opinion leaders is intended to be a compilation of different views on the relevant issues currently in debate from the perspective of a social scientist or ethicist, a natural scientist, and stakeholders from industry and civil society.

Ineke Malsch: You use TECHFARM to identify trends in converging (nano, bio, info and cogno) technologies. What is TECHFARM?

Ashok Vaseashta: TECHFARM stands for Technology Foresight, Assessment and Road Mapping. We propose to use a variety of instruments for assessing, forecasting, and predicting technology developments in the near future and their potential societal implications. Currently, the future societal implications of nanotechnology are largely unknown. TECHFARM is a great tool for policy makers who need to make decisions based on scientifically validated information. In the first year of our study and we applied several methods towards defense applications of nanotechnology. This has resulted in a roadmap identifying which technologies should be developed into a prototype and considered for investment. In the second year we hope to expand further the scope of our study.

Ineke Malsch: What are the main ethical and societal issues currently in debate on nanotechnology, ICT, privacy and security according to you? What is your view on those issues? How should they be addressed?

Ashok Vaseashta: Inclusion of Information and Communications Technology (ICT) will play a significant role in safety, security, and overall situational awareness for safety and security personnel. Furthermore, inclusion of ICT will have a major impact on medical and sports industries. With introduction of every new technology, there is always a level of skepticism leading to debate on risk vs. benefits and societal concerns such as ethics and privacy. Having advantage of the latest technological tools at our disposal, we no longer have to deal with speculations. The scientific community has the ability to use the latest tools at their disposal to create "safety by design". A strong sense of ethics coupled with mandatory and not a "voluntary code of conduct" i.e. a set of guidelines that will allow us to reap the full benefits of new technologies.

The three main issues from a policy perspective are public perception of nanotechnology, neurogenetics and standardization. The primary concern is the perception of non-technical people. This is hard to quantify and it is difficult to make policy recommendations as how to deal with it. There are different levels of perception. Education is needed to overcome disconnect between scientists and end-users of products enabled by nanotechnology. New guidelines should be developed on the contents of the education to stimulate the right perception. For example, public perception on the self-replicating nature of nano-systems is not realistic. Although research to make self-adaptive, reflective, and healing materials is in progress, self-replicating nature of nanosystems is fictional at this point.

A related issue is the public perception of nano-neurogenetics and its ethical implications. Societal groups are concerned about new technologies enabling prediction and alteration of the potential of neural development and its neuropsychiatric manifestations of cognition, emotion and behavior. Nanomaterials could in the public imagination be used for enhancement of human performance. One of the ways discussed is altering the structure of DNA and the development of neuron pathways. This could, in the public eye, influence human cognition and emotion. Another possibility discussed is to form an Avatar, or a better image of a person. In reality, nanotechnology is used for applications such as improvements of a soldier's uniform. Furthermore, addition of time and physiological-condition triggered drug-delivery systems embedded in soldier's uniform will enable the soldier to get out of harms' way, in an event of a serious injury in battle-field. This is a likely development that is not necessarily classified as performance enhancement.

A third main issue is the lack of uniform standards for nanomaterials. Most scientists and engineers follow a "voluntary code of conduct" as compared to a uniform set of standards. Standards organization must organize larger working groups to develop standards as soon as new nanomaterials are identified.

Currently, material safety data sheets give information on the bulk material, not on nanoformulations of the same material. This is a problem because the nanoform of the same material can have very different properties than the bulk form. For nanomaterials, currently only Materials Safety Data Sheets exist for Carbon Nanotubes. For other materials as well, the dimensions of the materials and dimension-related properties should be included in these sheets. On 08 December, the US National Nanotechnology Initiative is organizing a meeting on this and other aspects in Washington DC. A Finnish delegation may also participate. They should discuss the allocation of resources to build up the knowledge base. This is important because nanotechnology will become a mainstream technology which needs to be standardized. In May or June I plan to organize an S&T meeting in Washington D.C., on foresight of applications of nanomaterials and societal as well as technological implications.

Another relevant issue is concern about integrity, authenticity, and privacy of data transmitted by nanosensors (employing TinyOS). Societal groups are concerned about quantity, quality, and integrity of data transmitted by the nanosensors. The sensors are developed to be incorporated in soldiers' uniforms to monitor their health status (e.g. blood pressure, heart rate) and be integrated in a data network. It is important for soldiers that their health is monitored by their commanding officers, so they have a better chance of surviving injuries. At some future time, such sensor-networks will enter the civilian market. Privacy sensitive data could be transmitted over open networks and may even be compromised. Eventually, Privacy Enhancing Designs including more sophisticated encryption algorithms will be required to improve privacy concerns with sensors networks.

Apart from these main issues, there are also other current issues (see annex). Most of these concerns can be addressed by appropriate dissemination of information, and emphasis on study of nanomaterials and its environment. During the Spring Meeting 2011 of the Materials Research Society I will address all these issues in an invited presentation at the 3rd Business of Nanotechnology session. That will be a good opportunity to raise the awareness of these issues among the business community.

Ineke Malsch: Which societal groups (e.g. policy makers, business, natural scientists and engineers, social scientists and philosophers, NGO's, politicians) are currently involved in the debate? What role does each group play? Should the current stakeholders change their role and/or should other groups get involved?

Ashok Vaseashta: In the USA, several federal government departments participate in this debate. The European Commission is also involved, and several projects funded from the EU Seventh Framework Programme for RTD offer platforms for the debate including ObservatoryNano, ICPC-NanoNet and NANOPLAT. In Asia, the Asia Pacific Economic Forum is tabling discussion of these issues. Relevant NGOs include standardization bodies such as ISO (International Standards Organization) and the American Society of Testing of Materials (ASTM). Furthermore in the USA, PIPS (Potomac Institute of Policy

Studies) and C-PET (Center for Policy on Emerging Technologies) engage in the discussion from a non-governmental perspective. PIPS has a direct link with the PCAST President's Council of Advisors on Science and Technology and other policy makers in Washington DC. C-PET is playing a similar role. I will be working with PIPS in a newly created Center of Advanced Sciences Convergence, jointly with NUARI, to direct research on converging science and technologies. I am partially funded by a contract from the Department of Defense to advise DoD on technological aspects of scientific convergence and opportunity with PIPS will enable me to develop recommendations on policy aspects as well.

Government and Federal agencies should improve their interagency coordination and data sharing. My role on the boundary inside and outside of the government can serve to facilitate such coordination by organizing workshops by bringing all relevant and key-players together and avoid duplication of effort. Governments should also avoid lobbyists. By lobbyists, I mean representatives serving a very narrow interest with a specific agenda. The public interest should serve a broader goal, benefitting public-at large when nanotechnology enters the mainstream. All stakeholder groups should be represented. The NGOs I am aware of contribute to data mining using information in the public domain, including heuristic, in matter relating to the policy making discussion. I also recommend that politicians should have more involved interactions with the top scientists and futurists.

Ineke Malsch: Is there a need for particular new regulation or voluntary measures to govern responsible development of nanotechnology in ICT and security technologies? At which level should such measures be taken (national, EU, global)?

Ashok Vaseashta: New regulation or voluntary measures to govern responsible development of nanotechnology in ICT and security technologies is an interesting topic and will require several tiers of regulations. First of all – the measures should be global due to distributed nature of technology – so that the societal issues are addressed first rather than debates concerning its ownership. I foresee 2-3 different tiers of regulations – such as dealing with defense and security, emergency responders, and civilian use. The regulations are different in each tier. No public domain information should be available on regulations for defense and security applications. E.g. it will be necessary to develop regulations for sensors embedded in battle suits, but this can't be made public. For emergency responders and civilian use, regulations don't exist yet for applications of nanotechnology and converging technologies. For civilian use - new regulations to govern responsible development of nanotechnology in ICT and security technologies is much needed and will require a series of meetings to articulate such regulations.

Ineke Malsch: How do you see your own role in the developments and discussions?

Ashok Vaseashta: My personal role is towards technology foresight and assessment. Coupled with my own background in science and technology, I use a series of cross-cutting tools, synergy, and scientific methodologies for developing future trends in nanotechnology and how science convergence may provide new technological tools. I also raise awareness to use the technology in a way that society is comfortable with its use. I promote the discussion by identifying technology gaps, suggesting ways to fill the gaps, and promote dialogue between scientists and society.

My main interest is in interactions of nanotechnology with its environment. In my communications, I discuss how nanotechnology interacts with the human body. It depends on the physiological condition of the person and his environment. This is the least understood subject. I also try to raise awareness of the fate and transport and life-cycle analysis of nanomaterials, e.g. how the nanoparticles originate and how they are transported in the environment. In my position, I try to educate the public to understand the issues by combining my work as a scientist, educator and as policy advisor. The main objective is to shift the perception from risk dominated paradigm to "safety-by-design" applications of nanotechnology.

Identification

Name: Prof. Dr Ashok Vaseashta
Function: Director Institutes of Advanced Sciences Convergence and International Clean Water
Organization: Norwich University Applied Research Institutes
Country: USA
Website: <http://www.nuari.org>

Role in debate on nanotechnology, ethics and society:

Ashok Vaseashta is Director of the Institutes of Advanced Sciences Convergence and International Clean Water. In addition, he is visiting professor at 3 Nano-SAE Research Centre, University of Bucharest, Rumania: <http://www.3nanosae.org/> and visiting scientist at Helen & Martin Kimmel Centre of Nanoscale Science, Weizmann Institute, Israel: <http://www.weizmann.ac.il/kimmel-nano/>. He holds a special assignment with the U.S. Department of State. His research interests include chemical and biological sensors, counter-terrorism, water safety & security, environmental pollution monitoring & remediation and green nanotechnology. He proposes to use TechFARM (Technology Foresight, Assessment and Roadmapping) for mapping trends in converging technologies (Nano, Bio, Info, Cogno). He will deliver the Albert Franks Memorial Lecture, 3 February 2011 organised by the Institute of Nanotechnology: <http://www.nano.org.uk/events/ionevents.htm>

Relevant recent publications and projects

By Ashok Vaseashta: 4 Books on Nanotechnology, Chem.-Bio Sensors
Over 200 research publications.

Grants/Contracts: as PI: over 1.5 Million US Dollars.

As Co-PI: over 5 Million US Dollars.

Over 90 Keynote, Invited, memorial lectures

Director: 3 NATO Advanced Study Institutes.

Representative references related to policy aspects:

1. NNI Strategic Planning Stakeholders' Workshop, 13-14 July 2010, Arlington VA. Draft Workshop Report - 24 November 2010.
2. Societal Dimensions Research in the National Nanotechnology Initiative, Gunston, D. H. CSPO#10-02. 21 May 2010.
3. Nanomaterials – Applications, Risks, Ethics, and Society, Vaseashta, A. in Nanomaterials Risks and Benefits by Linkov, I. and Steven, J. Springer 2009.
4. Nanotoxicology and Ethical Conditions for Informed Consent, Shrader-Frechette, Kristin. Nanoethics, Vol. 1, pg. 47-56, 2007.
5. Potential Toxicity of Nanomaterials and their Removal, Zhu, X. et al. International Perspectives on Environmental Nanotechnology – Applications and Implications. EPA 905R09032 Nov 2009.
6. Nanomaterials Nexus in Environment, Human Health, and Sustainability, Vaseashta, A. Silicon Vs. Carbon – Fundamental Nanoprocesses, Nanobiotechnology, and Risk Assessment by Magarashek, Y, Kozyrev, S. and Vaseashta, A. Springer 2009.
7. Advanced Sciences Convergence for Defense and Security. Vaseashta, A. et al. Vol. 1209 MRS- Business of nanotechnology II (2009).

Annex:

Apart from the main issues identified by Ashok Vaseashta, he is also aware of the following other issues. Most of these concerns can be addressed by appropriate dissemination of information, and emphasis on study of nanomaterials and its environment.

- Adverse impact of interaction of nanomaterials with human body: Insufficient experimental evidence exists in literature to indicate that nanomaterials pose sufficient risks to humans. More specifically, delineation of interaction of nanomaterials produced in a controlled environment vs. generated incidentally (or by nature) is necessary to be addressed.
- Potential use of nanomaterials as biological agents and for genetically modified biological structures (synthetic biology): No comment at this time due to security reasons.
- Bio-accumulation of nanomaterials within human body: dimension of nanomaterials vs. bioaccumulation onset needs to be studied in much more detail.
- Use of nanomaterials for Human performance Enhancement (HPE): There is a growing concern on this issue, especially in sports. Research efforts towards enhancing battlefield capability of soldiers are in progress.
- Societal outlook when nanotechnology becomes mainstream: Due to ongoing debate and lack of sufficient accurate information, there is a growing societal concern about use of nanomaterials once the nanotechnology becomes mainstream
- Ownership and hence liability of nanotechnology: Societal concern as who owns a specific technology and should something undesirable occurs – who is liable.

- Risk/benefit analysis of use of nanotechnology: Insufficient information about interaction of nanomaterials of its environment furthers societal concerns due to lack of cost/benefit and risk/benefit analysis.
- Interaction of nanotextile with human: Interaction of nanomaterials with biological cells and other surrounding mediums needs to be studied in greater detail to address this societal concern.
- Use of nanobased products for domesticated pets: Same as above.
- Distinction of engineered, incidental, and nature produced nanomaterials – and their interaction with human and domesticated pets. Classification and characterization.

List of groups pursuing societal implications of nanotechnology:

US

NSF – National Science Foundation

EPA - Environmental Protection Agency

DoS – U.S. Department of State

DoJ – Department of Justice

NNI: National Nanotechnology Initiative

NNCO: National Nanotechnology Coordination Office

Europe:

EU/CORDIS

Asia

APEC: Asian Pacific Economic Forum

NGOs

ISO: International Standards Organization

ASTM: American Society of Testing of Materials

PIPS: Potomac Institute of Policy Studies

C-PET: Center for Policy on Emerging Technologies

FP7 Projects

ObservatoryNANO

ICPC NANONET

NANOPLAT

Politicians

Several.

(Not provided for reasons of attribution)

About observatoryNano

The observatoryNANO project is funded under FP7 for four years from April 1st 2008. Its primary aim is to support European decision-makers with information and analysis on developments in nanoscience and nanotechnology (N&N). It will collate and analyse data regarding scientific and technological (ST) trends (including peer-reviewed publications, patents, roadmaps, and

published company data) and economic realities and expectations (including market analysis and economic performance, public and private funding strategies). The ST and economic analysis will be further supported by assessment of ethical and societal aspects, impacts on environment, health and safety, as well as developments in regulation and standardisation. Although much of this work will be performed within the consortium, the project is working cooperatively with other initiatives to ensure that effort is not duplicated and that resource sharing and output are maximised. To date liaisons have been established with international organisations including the EPO, OECD, and ISO, and will continue to be established with other relevant organisations such as European Technology Platforms (ETPs), ERA NETs, and other EUfunded projects.

The observatoryNANO project is led by the Institute of Nanotechnology (IoN) (UK), and includes: VDI Technologiezentrum (DE), Commissariat à l'énergie atomique (CEA) (FR), Institute of Occupational Medicine (IOM) (UK), Malsch TechnoValuation (MTV) (NL), triple innova (DE), Spinverse (FI), Bax and Willems Consulting Venturing (B&W) (ES), Dutch National Institute for Public Health and the Environment (RIVM) (NL), Technical University of Darmstadt (TUD) (DE), Associazione Italiana per la Ricerca Industriale (AIRI) (IT), Nano and Micro Technology Consulting (NMTC) (DE), Swiss Federal Laboratories for Materials Testing and Research (EMPA) (CH), University of Aarhus (DK), MERIT - Universiteit Maastricht (NL), Technology Centre AS CR (CR).

For further information please contact the project coordinator Eleanor O'Rourke eleanor.orourke@nano.org.uk or visit the project website: www.observatorynano.org

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