Centro Militare di Studi Strategici

Research Paper 2010 STEPI-T-1 .1.1

NOOCLASTIC THREATS:
Beyond intraspecific war
Deliberate Misuse of Nanotechnology

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Closed: January 2011

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EXECUTIVE SUMMARY

NOOCLASTIC THREATS: Beyond intraspecific war.

Deliberate Misuse of Nanotechnology

We all know how fast the technological progress nowadays is. No one can predict the future, but, in the case of radically transforming technology, a better understanding of what we are doing, of where we are going (and how) is needed. Humankind could be really close to a critical era of his history. Nanotechnology, artificial intelligence, genetically engineered biological agents and other innovations could bring with them both opportunities and risks.

Nick Bostrom[1], well-known philosopher and eminent Professor of Philosophy at the Oxford University, wrote a lot about "Existential Risks". He believes that mankind has ever been at risk, and that there are different typologies of threat, depending on the period we are considering (the perils in medieval times, in the 1970 and nowadays are different).

In his interesting works, he classifies (Figure 1) the risks in a matrix based on: *scope* (size of group of people at risk), *intensity* (how badly each individual would be affected) *and probability*[2] (the current subjective estimation of the probability of an adverse outcome).

[1] **http://en.wikipedia.org/wiki/Nick_Bostrom**

[2] For a more detailed study about probabilities of existential risks see *"Global Catastrophic Risks"* N. Bostrom and M.M. Circovic, Oxford university Press, 2008 (http://www.global-catastrophic-risks.com/more.html or http://www.amazon.com/Global-Catastrophic-Risks-Nick-Bostrom/dp/0198570503). See also *"Global Catastrophic Risks Survey"* A. Sandberg and N. Bostrom, Technical Report 2008/1 published by Future of umanity Institute, Oxford University Press (http://www.fhi.ox.ac.uk/selected_outputs/fohi_publications/global_catastrophic_risks_survey).

Scope			
global	Thinning of the ozone layer	**X**	
local	Recession in a country	Genocide	
personal	Your car is stolen	Death / life sentence	
	endurable	terminal	*Intensity*

Figure 1: from "*Existential Risk – Analyzing human extinction scenarios and related hazards*" - Nick Bostrom, published in the *Journal of Evolution and Technology*, Vol.9, March 2002.

We can define "endurable" and "terminal" risks to better understand the matrix above: the first may cause a great destruction, but a person (or the population) can either recover from the damage or find ways of coping with the fallout. The second is one where the victims are either annihilated or irreversibly crippled in ways that radically reduce their potential to live the sort of life they aspire to. According to Bostrom, it is interesting and vital to know in advance the global, terminal risk. In the square of the matrix in "Figure 1", marked with an "X", we find the so called "Existential Risk" which is defined as "one where an adverse outcome would either annihilate Earth-originating intelligent life or permanently and drastically curtail its potential"[3]. This means that humankind *in toto* is imperiled in the case of global-terminal risk category.

Dangerous animals, poisonous food, automobile accidents, Chernobyl, volcano eruptions, earthquakes, epidemics, World Wars, smallpox, AIDS are not only risks but also real and frequent occurrences that helped us in the past and now to shape our intuition and coping strategies. Those tragic events have not significantly affected the total amount of human

[3] *"Exixtential Risk – Analyzing human extinction scenarios and related hazards"* - Nick Bostrom, published in the *Journal of Evolution and Technology*, Vol.9, March 2002.

suffering or happiness or determined the long-term destiny of our species. For this reason they don't fall into the category we are going to write about in this paper.

The first manmade existential risk was probably the atomic bomb. At the time of its inaugural detonation, somebody thought that this war-technology innovation could start a chain-reaction by "igniting" the atmosphere. Nowadays we all know that it is impossible, but at the time it could have been classified as "global/terminal risk". Linked to this, another existential risk was the build up of nuclear arsenals in the US and the USSR. With the information available at the time and studying the feelings of the decision makers there was a real worry that a Nuclear **Armageddon**[4] would occur and destroy permanently human civilization. **John Von Neumann**[5] (1903-1957), eminent mathematician and chairman of the Air Force Strategic Missiles Evaluation Committee as well as architect of early US nuclear strategy, said he was "absolutely certain that there would be a nuclear war; and that everyone would die in it"[6]. According to a lot of academics (N. Bostrom, **J. Tickner**[7], **D. K. Lewis**[8]), it is sufficient to have a subjective probability of an adverse outcome to be at risk, even if later the situation changes in something absolutely not negative. We base our decision on the subjective sense: "If we don't know whether something is objectively risky or not, then it is risky in the subjective sense"[9]. The illogical consequence of this is that naturally everyone uses his best current subjective estimation of the objective risks factors[10] instead of using a more reasoned, thoughtful and laid approach to dangerous situations.

According to Bostrom the following points illustrate the nature of the challenges posed by existential risk:

a) The approach to existential risk doesn't leave space to mistakes. It shouldn't be a trial-and-error approach, we must be proactive: this means anticipates new types of threats, be intentioned to take decisive preventive actions and bear the costs of such actions.

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[4] **http://en.wikipedia.org/wiki/Armageddon**
[5] **http://en.wikipedia.org/wiki/John_Von_Neumann**
[6] *"The place of the facts in a world of values"* - Putnam H., published in D. Huff & O. Prewett (Eds.), the Nature of the Phisical Universe. New York: John Wiley.
[7] **http://en.wikipedia.org/wiki/J._Ann_Tickner**
[8] **http://en.wikipedia.org/wiki/D._F._Lewis**
[9] See *"The Precautionary Principle"* - Tickner J. (2000) URL: http://www.biotech-info.net/handbook.pdf .
[10] See *"Philosophical Papers"(Vol. 2)* - Lewis D., (1986) New York, Oxford University Press. See also *"A Subjectivist Theory of Objective Chance"* - Bostrom N., British Society for the Philosophy of Science Conference, 8-9 Joly, Nottingam, U.K..

b) We can't believe that moral norms or institutions could solve easily every kind of threat for us: no one has never witnessed such disaster.

c) Everybody is menaced by the existential risk and probably it is needed an international action; no one wants to minimize the national sovereignty but existential risk has to be considered a "global public good"[11] to take the correct countermeasures in time against the major danger.

d) If we consider the welfare of future generations we must also pay attention on whether and how much we discount future benefits to solve the problem of existential risks.

Existential risks can be classified in *Bangs, Crunches, Shrieks* and *Whimpers.* The *Deliberate Misuse of Nanotechnologies* is considered a "Bang"[12]: this category envisions the possibility of the end of the world and the extinction of intelligent life, in a relative short and sudden time, caused by either an accident (like Naturally occurring disease, Asteroid or Comet impact, Runway global warming) or a deliberate act or a manmade new-technology act (like Nuclear holocaust, We are living in a simulation and it gets shut down, Badly programmed super-intelligence, Genetically engineered biological agent, Accidental misuse of Nanotechnology)… A Bang is «the most obvious kind of Existential Risks»[13] and, according to Bostrom, *Deliberate Misuse of Nanotechnologies* is the most probable.

Bostrom underlines how little work has been done till March 2002 in this area and he also says that the point is "to take a sober look at what could go wrong so we can create responsible strategies for improving our chance of survival"[14]. This is also the aim of this research paper: trying to give a particular description of the *Deliberate Misuse of Nanotechnologies* and to discuss the implications from the military point of view.

[11] *"Global Public Goods"* – Kaul I. (1999), Oxford University Press. Available at: http://www.undp.org/globalpublicgoods/TheBook/globalpublicgoods.pdf#page=40

[12] The terminology is inspired by "*The Hollow Men*" by T. S. Eliot: *"This is the way the world ends / Not with a bang but a whimper"*.

[13] *"Exixtential Risk – Analyzing human extinction scenarios and related hazards"* - Nick Bostrom, published in the *Journal of Evolution and Technology*, Vol.9, March 2002.

[14] *"Exixtential Risk – Analyzing human extinction scenarios and related hazards"* - Nick Bostrom, published in the *Journal of Evolution and Technology*, Vol.9, March 2002.

1 What Nanotechnologies could do/cause.

The famous technologist and futurist **Alvin Toffler**[15]**,** in 1970, was one of the first that argued that technological acceleration and social change will surely modify the capacity of individuals and institutions to understand and to adapt to it[16]. Actually some futurists (as **Raymond Kurzweil**[17]) state that sometime in the middle of this century life will be radically different than any prior time thanks to the new technologies. I think that this last sentence is undeniable. As we can see in our life, technologies help us in everything: new tech for the car, for the medicine, to listen the music, etc.. But what is Nanotechnology? Where do we stand with the research in this area? What are its implications and the sciences covered by Nanotech?

Nanometer[18] (nm) is one billionth of a meter and, in comparison, we can say that the width of an average hair is 100000 nm, human blood cells are 2000~5000 nm, the diameter of a strand of DNA is 2,5 nm[19]. These examples make us understand that the ability to manipulate matter at this level is closely connected to the ability to manipulate life at its basic level (i.e. atoms and DNA).

Nanotechnology can be defined as

> «The science, engineering, and technology related to the understanding and control matter at the length scale of approximately 1 to 100 nanometers. However, nanotechnology is not merely working with matter at the nanoscale, but also research and development of materials,

[15] **http://en.wikipedia.org/wiki/Alvin_Toffler**
[16] *"Future Shock"* – Amereon Ltd. (1970). http://www.amazon.com/Future-Shock-Alvin-Toffler/dp/084880645X
[17] **http://en.wikipedia.org/wiki/Ray_Kurzweil**
[18] **http://en.wikipedia.org/wiki/Nanometre**
[19] Cfr. *"Small wonders, endless frontiers: a review of the National Nanotechnology initiative"* (2002) – National Research Council, Washington D.C. available at: http://www.nap.edu/openbook.php?isbn=0309084547 .

devices, and systems that have novel properties and functions due to their nanoscale dimensions or components.»[20]

A British report defined nanotechnology as

«the design, characterization, production, and application of structures, devices and systems by controlling shape and size at nanometre scale.»[21]

«Nanotechnology (NT) can be described as the manipulation of materials or devices at the nanometer scale (one billionth of a meter), often at the level of individual atoms and molecules. NT is considered to be the next fundamental revolution in technology, because it enables the structuring of matter at the level of fundamental building blocks. At the nanoscale, the laws of quantum mechanics are applied. The importance of gravity diminishes, while the importance of forces existing among fundamental units (molecules, atoms) increases.»[22]

The application of nanotechnology can occur in one, two or three dimensions:

- in one dimension it includes the use of an oxygen plasma 25 atoms thick to bind a layer of **indium phosphide**[23] to silicon in order to make a computer chip that uses lasers to transmit data at 100 times the speed of current communications equipment[24];

- in two dimensions it includes the manufacture of carbon nanotubes only 1nm in diameter that may eventually reach several centimetres in length;

- in three dimensions it encompasses the manufacture of small particles no more than a few nanometres in any dimension that might be used as an ingredient in sunscreens or to deliver drugs to a specific type of cell in the body.

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[20] The National Nanotechnology Initiative at Five Years: Assessment and Recommendations of the National Nanotechnology Advisory Panel, President's Council of Advisors on Science and Technology, Washington D.C., May 2005.

[21] "*Nanoscience and Nanotechnologies: Opportunities and Uncertainties*", Royal Society and The Royal Academy of Engineering, UK, July 2004. http://www.nanotec.org.uk/finalReport.htm

[22] *"The security implications of Nanotechnology"* – Lothar Ibrügger - *170 STCMT 05 E*; http://www.nato-pa.int/default.asp?shortcut=677.

[23] **http://en.wikipedia.org/wiki/Indium_phosphide**

[24] *"A Chip That Can Move Data at the Speed of Laser Light"* - John Markoff; New York Times, September, 18, 2006. http://query.nytimes.com/gst/fullpage.html?res=9B05E4D71331F93BA2575AC0A9609C8B63&sec=&spon=&pagewanted=2 .

How is nanotechnology progressing? Since 1953 biologists have known about the basic building blocks of DNA, but in the last decade[25] they listed the exact DNA sequence of a human being. Now scientists not only know the DNA sequence, but they have also used this knowledge to build a virus that assembles a battery[26]. Another example is that now scientists can place a 20 nm indentation on a piece of material, creating a data storage system with the capacity to store 25 million printed textbook pages on a square inch chip[27], rather than just being able to see individual atoms with an electron microscope.

The two examples above show us that science at nanolevel is more than a natural technological progression because understanding how chemical-biological processes work and, more importantly, being able to manipulate nanometric events in order to get specific outcomes, open up the possibility of significant new advances in a great numbers of fields: electronics, medicine, material sciences...also with military applications in new weaponry. Relatively harmless forms of toxins or chemicals could be easily obtained and with minimal manipulation tools it is possible to make them lethal, through their ability to interact with the body, altering the metabolic processes. This is simple technology, much simpler than that required to produce the traditional chemical or bacteriological weapons. For example, it is theoretically possible, through a nano-machine, to manufacture **anthrax toxin**[28] in large quantities, molecule by molecule, without having access to Bacillus anthracis25[29]. Moreover at this scale the physical, chemical, and biological properties of materials differ in fundamental ways from the properties of either individual atoms or bulk matter[30], which means that material at the nanoscale can exhibit surprising characteristics that are not evident at large scales. It has to be underlined that in the last 15 years nanotechnology has begun to grow thanks to both the economic pressures/investments and the

[25] Of special importance is the "Human Genome Project" (HGP) with his primary goal of determining the sequence of chemical base pairs DNA since 1990. A working draft of the genome was released in 2000 and a complete one in 2003.
[26] *"Powerful Batteries That Assemble Themselves"* - Technology Review, available at: http://www.technologyreview.com/Energy/17553/
[27] "*Nanotechnology for Dummies"* - Richard Booker and Earl Boysen; Wiley Publishing Inc., (2005). http://www.amazon.com/Nanotechnology-Dummies-Richard-D-Booker/dp/0764583689
[28] **http://en.wikipedia.org/wiki/Anthrax_toxin**
[29] Cfr. *"Nanoscienze e Nanotecnologie"* – Presidenza del Consiglio dei Ministri – Comitato Nazionale per la Bioetica - Seduta Plenaria 9 giugno 2006. www.governo.it/**bioetica**/testi/nanoscienze_nanotecnologie.pdf
[30] The National Nanotechnology Initiative Strategic Plan, National Science and Technology Council, Washington D.C., December 2004, p. i.

development of new instruments that let the scientist observe and manipulate matter at the nanolevel (e.g. **scanning tunnelling microscopy**[31] and electron microscopy).

It seems appropriate to linger and better define what advanced nanotechnology is. In this case, the nanotechnology not only provides new opportunities for technology to produce materials or plastic/chemical substances (**nanotubes**[32], nanoparticles, nano-capsules, nanodots, nano wires) but also combines inorganic nanomaterials with organic molecules. Thus, advanced nanoparticles are involved in cellular metabolism to influence the production of molecules or the transmission of information or to create new cellular structures, new complex molecules, assemblers. In short, we will have the power to intentionally alter living organisms through DNA manipulation to create "molecule size machines" (nanodevices analyzing a variety of macromolecules piece by piece, penetrating and incorporating into cellular living organisms)[33].

According to Drexler those devices are called "assemblers" and they will be living machines capable of self replication.

M. C. Roco[34], leader in nanotechnology policy, has recognized four phases in the development of nanotechnology products, to which it can be added a possible fifth[35]:

- *Passive Nanostructures (2000-2005).*

  In this first period the passive properties of nanomaterials, including nanotubes and nanolayers, gives more and more opportunities to renew products of everyday life: the sunscreens are transparent thanks to the properties of titanium dioxide at nanolevel; tennis racket is lighter and harder thanks to carbon nanotubes; etc.

- *Active Nanostructures (2005-2010).*

  Nanostructures become active in this phase and they change their state during the use in a way that can be predicted. The structure of nanomaterials and its properties require more and more attention to design unique materials and products.

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[31] **http://en.wikipedia.org/wiki/Scanning_tunneling_microscope**
[32] **http://en.wikipedia.org/wiki/Nanotube**
[33] Cfr. *"Engines of Creation"* - Drexler K.E., New York: Anchor Press, 1986 http://e-drexler.com/p/06/00/EOC_Cover.html ; *"Nanosystems"* - Drexler K.E., New York: Wiley-Interscience, 1992. http://e-drexler.com/p/idx04/00/0411nanosystems.html .
[34] **http://en.wikipedia.org/wiki/Mihail_Roco**
[35] "*Nanoscale Science and Engineering: Unifying and Transforming Tools"* - M.C. Roco; AIChE Journal Vol. 50, No. 5. Recently, Dr. Roco chaired the U.S. National Science Technology Council's Subcommittee on Nanoscale Science, Engineering and Technology. http://www.nsf.gov/crssprgm/nano/reports/mcr_04-0101_visionnt@aiche_final.pdf

- *Systems of Nanosystems (2010-2015).*

  In this 5 years assemblies of nanotools work together to achieve a final goal. This means that a great advancement in robotics, biotechnology, and new generation information technology will appear: nanostructure could self assemble into a lattice on which bone or other tissues could grow; small nanoelectromechanical devices could search out cancer cells and turn off their reproductive capacity; etc.

- *Molecular Nanosystems (2015-2020).*

  This stage involves the intelligent design of molecular and atomic devices, leading to "unprecedented understanding and control over the basic building blocks of all natural and man-made things."[36] This indicates an increasing ability to study and manipulate the interaction between light and matter, the machine-human interface, and atomic manipulation to design molecules.

- *The Singularity (2020 and beyond).*

  After this forecast the question is: what happens after 2020? Probably technology will continue. Some observers estimate a period at which scientific advances aggressively assume their own momentum and accelerate at unprecedented levels, enabling products that today seem like science fiction. **Beyond the Singularity**[37], human society is incomparably different from what it is today. Several assumptions seem to drive predictions of a Singularity[38]. Probably computers or intelligent machines start to produce discoveries that are too complex for humans and the consequent assumption is that solutions to most of today's problems (i.e. material scarcity, human health, and environmental degradation) can be found by technology, if not by us, then by the computers we eventually develop.

As M.C. Roco indicates, all the timeframes indicated above obviously are subject to delays because research in this fields is influenced by a lot of factors first of all funding and industries requests.

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[36] *"International Perspective on Government Nanotechnology Funding in 2005,"* - M.C. Roco, *Journal of Nanoparticle Research*, Vol. 7, No. 6. http://www.nsf.gov/crssprgm/nano/reports/mcr_05-0526_intpersp_nano.pdf

[37] **http://en.wikipedia.org/wiki/beyond_Singularity**

[38] *"The Singularity is Near: When Humans Transcend Biology"* - Ray Kurzweil, Viking Press (2005). http://www.amazon.com/Singularity-Near-Humans-Transcend-Biology/dp/0670033847

The purpose of using nanotechnologies could be surely noble and useful for the humankind: seek out cancer cells, repair DNA anomalies or rupture, solve the problem of **ozone depletion**[39], etc. But we can't forget that this research paper is focused on risks given by the possible misuse of nanotechnology and new kinds of weaponry that can be built thanks to nanotech. There is a lot of perspective implications in arms industry and military affairs, like a new type of "combat suit" to protect soldiers from explosion or fire, extremely light guns with special precision bullets, new power sources for airplanes (e.g. some kind of nanofuel or nanomaterial able to increase the speed or capability of aeronautical platforms), new nano-cameras that can spy the enemy, nanorobots that can kill or disable the enemy, nanobiological weapons, etc.. This is strictly connected to a question: how wars will be fought in the future?

After the Kuwait war (August 2, 1990 – February 28, 1991), US forces studied a modern propaganda based on new technologies and strong reasons: precision-guided long-range munitions, night vision and advanced sensors, satellite reconnaissance, stealth aircraft, high-mobility, rapid-fire tanks, flexible manoeuvre tactics, computerization of intelligence and logistics. This was said to constitute a **"revolution in military affairs" (RMA)**[40] that could guarantee swift victories with minimal losses and, at the same time, keep civilian casualties low.

Nanotechnologies and its implications in defence industries, international relations and society could be studied and classified as a RMA. A quick (and quickening) succession of "revolutions", connected to the actual technological improvement, may spark a new arms race involving a number of potential competitors. Older systems, including nuclear weapons, would become vulnerable to novel forms of attack or neutralization. Rapidly evolving, untested, secret, and even "virtual" (in the sense of experimentation phase weapons and/or weapons that permits a high level of **C4**[41] of forces – tactical links, satellite connections, etc.) arsenals would undermine confidence in the ability to retaliate or resist aggression. Warning and decision times would get smaller.

The distinction between confrontation and war will probably change because of covert infiltration of intelligence and sabotage devices. Overt deployment of ultramodern weapons, perhaps on a massive scale, would alarm technological laggards. This could

[39] **http://en.wikipedia.org/wiki/Ozone_depletion**
[40] **http://en.wikipedia.org/wiki/Revolution_in_Military_Affairs**
[41] It means Command, Controll Communications and Computer; **http://en.wikipedia.org/wiki/C4ISTAR**

shift dramatically the actual and perceived power balances. Those are all reasons that bring us to the evidence that if this "revolution in military affairs" has not already started, we will see it in the next few years.

> «With the advent of nanotechnology, the qualitative advances in weapons technology will be enormous and compelling; no country will want to maintain armies that are effectively impotent against a potential threat. Molecular manufacturing based on self-replicating systems, and super-automation by artificial intelligence, will also profoundly alter the issue of cost. A nation's military potential will depend first on its position in the technology race. A second factor will be its natural resource base, but most nations have access to sufficient natural resources to support an arsenal many times larger than any which has ever existed on Earth»[42].

Actually all nations are far from holding the lead in molecular manufacturing and self-replicating systems; but if in a close future becomes clear that it could be done, the race will start rapidly: the competitors will surely be US, Japan and Europe (those states which have the greatest concentration of advanced technologies), but Russia, China, India and Israel will not certainly stay apart. This kind of project could absorb a lot of efforts both economic and human, «there is good reason to believe that our capabilities are expanding rapidly enough to be able to meet this task within a few decades, it would be foolish to think that the task is one that can be accomplished by a small team in the near term»[43]. Costs in this field will be surely high but it could generate a great system of industries and, probably, immediate payoffs. Thus, even countries that can't afford R&D programmes or private industries, will not be too far from leading powers in nanosystems and nanorobots. It's obvious that the country which firstly will cross the threshold of molecular manufacturing, will surely be a step forward the other competitors.

At the present time "nuclear weapons" is the most powerful deterrent until nanosystems have reached a very refined progress, and even then would decision makers have the courage to risk an attack which could imply nuclear arsenal and nanorobots on a large scale?

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[42] Cfr. *"Nanotechnology and international security"* – M. A. Gubrud, University of Maryland, College Park, MD 20742-4111. http://foresight.org/Conferences/MNT05/Papers/Gubrud

[43] *"Nanotechnology and international security"* – M. A. Gubrud, University of Maryland, College Park, MD 20742-4111. http://foresight.org/Conferences/MNT05/Papers/Gubrud

K.E. Drexler[44] and M. A. Gubrud wrote that probably, in the first few decades of 21st century, assembler-based molecular nanotechnology could be developed and this could be a potential factor causing chaos and disruptions. According to Drexler and Gubrud there are many key areas of concerns but, from a military perspective, «in the absence of a "balance of terror" a confrontation between more or less equally advanced terrestrial nanotechnology powers could be unstable to pre-emption »[45]:

- *Arms race instability*. If we imagine, as M. A. Gubrud suggests in a typical bipolar vision which is exceeded nowadays[46], a great imbalance between two states or coalitions of states in deployed hardware, one side could feel empowered to strike with no restrictions. The danger of falling behind on an exponential curve, not to be the weakest part, «would create unprecedentedly strong pressures to initiate or join and to maintain or gain the lead in a quantitative arms race.»[47] Large quantities of military hardware could be produced in a really short time

- *First strike instability*. If we imagine two powerful states or coalitions of states which have the same level of nanotechnology and deployed armaments, the military stability is not sure: one side could decide a surprise attack to decimate the opposite forces before they could respond. This, according to Gubrud, could happen in co-occupied environments (i.e. oceans, land line of confrontation) in which no one wants to leave much space to the enemy. The first who hits with the greatest density of interpenetrating forces and the shortest strike time may gain an irreversible advantage. For those reasons a perfect balance of technical and material resources could be unrealistic in any case, this leads to a new type of strategic instability:

- *Early advantage instability*. According to M. A. Gubrud:

> «If one has an early lead in a replicator-based crisis arms build up, the fact that a competitor may have somewhat faster replicators or superior weaponry, or may have access to a larger primary resource base, provides another strong stimulus to an early first strike.

[44] Cfr. *"Engines of Creation"* - Drexler K.E., New York: Anchor Press, 1986 http://e-drexler.com/p/06/00/EOC_Cover.html ; *"Nanosystems"* - Drexler K.E., New York: Wiley-Interscience, 1992. http://e-drexler.com/p/idx04/00/0411nanosystems.html . (**http://en.wikipedia.org/wiki/K._Eric_Drexler**)
[45] *"Nanotechnology and international security"* – M. A. Gubrud, University of Maryland, College Park, MD 20742-4111. http://foresight.org/Conferences/MNT05/Papers/Gubrud
[46] See pag. 16 for a more modern picture of the topic.
[47] Ibidem.

> Moreover, it is unlikely that one actually knows the performance of an enemy's weapons or production base, particularly after a long peace. Thus, a runaway nanotechnical arms race may be a race to nowhere; there may be no further island of stable military balance out there, even if we could manage to avoid war along the way.»[48]

For “misuse of nanotechnology” I mean the intentional use by a person/state/coalition of states (this subject will be better discussed in the following chapter) who endangers the life of a great number of people or even of mankind. The three hypothesis above show that not only the misuse of nanotechnology could bring instability, chaos and great damages, but also its exploitation in weapons industry could be really dangerous. Thus it is important to underline the great impact that every discovery and innovation in all branches of nanotechnology (chemistry, biology, medicine,…) could have on international relations and on the world balance of power.

[48] Ibidem.

2 Who against who/what?

Two basic questions have to be posed: who can afford those nanotechnologies? And what are their aims? In this chapter I'm going to analyze briefly those points.

Area	1997	1998	1999	2000	2001	2002	2003	2004	2005
US*	116	190	255	270	422	604	862	989	1081
Europe	126	151	179	200	225	400	~650	~950	~1050
Japan	120	135	157	245	465	720	~800	~900	~950
Others**	70	83	96	110	380	520	~800	~900	~1000
Total	432	559	687	825	1502	2174	3112	3739	4081
% of 1997	100	129	159	191	348	503	720	866	945

Figure 2. World-wide government funding for nanotechnology research and development (US $ million)[49].

* Excluding non-federal spending, (e.g. California).

** "Others" includes Australia, Canada, China, Eastern Europe, Singapore, Taiwan and other countries with nanotechnology R&D. For example, in Mexico there are 20 research groups working independently on nanotechnology. Korea, already a world player in electronics, has an ambitious 10-year programme to attain a world-class position in nanotechnology.

[49] Cfr. *"Worldwide Public Funding for Research and Development in Nanotechnology"* – available at: http://www.azonano.com/details.asp?ArticleID=1077 ; see also *"International perspective on governmental nanotechnology founding in 2005"* – M.C.Roco; Journal of Nanoparticle Research, Volume 7, Number 6, 707-712, DOI: 10.1007/s11051-005-3141-5. http://www.springerlink.com/content/7t5l75v66x52n885

The European Commission on September 14, 2007 was declared the "world's largest single funding agency worldwide" for nanotechnology. According to a report, the EU's 6th Research Framework Programme with 1.4 billion Euro allocated to 550 projects in the field of nanosciences and nanotechnology accounts for one-third of total public funding for nanotechnology. With the 7th Framework Programme (2007 - 2013), the commitment is further increased so that the funding provided for the topic that refers explicitly to nanotechnology (even if not exclusive), payable over the life of the Program, amounted to approximately € 3.5 billion and other funds referring to research programmes related to nanotechnology will be supplied in other areas[50].

President's Council of Advisor on Science and Technology[51] (PCAST) found that the United States is the acknowledged leader in nanotechnology research and development (R&D). The approximately $1 billion the Federal government spent on nanotechnology R&D in 2006 is roughly one-quarter of the global investment by all nations. Total annual U.S. R&D spending (Federal, State, and private) in 2006 stands at approximately $3 billion, or one-third of the estimated $9 billion in total worldwide spending by the public and private sectors combined[52].

The consolidated data about U.S. government funding in nanotechnology in 2007 indicate a cost of approximately $ 1.85 billion, in Japan the same year the public funds for research on nanotechnology were approximately of $ 1060, about 720 in Germany, in France 460, in the UK about 315 in South Korea 290 and in China about 250. Smaller Countries, but heavily involved in high tech sectors (e.g. Holland, Switzerland and Taiwan), devoted large sums to this sector in relation to their size[53].

Figure 2 and the data above mentioned show the great funds increment in nanotechnology R&D during the first years of 21st Century. This means that developing nations or an undeveloped R&D agency/organization surely can't be able to study and keep pace with the times in any nanotechnology branch. Only large teams of scientist, great funds and super-developed labs could achieve goals in early stage nanotechnologies. For these reasons, also a western country probably could not spend so much money, efforts and energies alone. Teams, of scientist from a group of countries, and funds, both public and

[50]Cfr. *"Nanotecnologie – competitività e innovazione per lo sviluppo industriale"*, Convegno Internazionale NANOTEC2009 http://www.nanotec2009.com/Ita/Homeita/Homeita.html.
[51] Cfr. **http://www.whitehouse.gov/administration/eop/ostp/pcast**
[52]Cfr. "Nanotechnology R&D Report Finds U.S. to be Global Leader in Nanotechnology Research and Development" , http://www.azonano.com/news.asp?newsID=938.
[53] Cfr. *"Nanotecnologie – competitività e innovazione per lo sviluppo industriale"*, Convegno Internazionale NANOTEC2009 http://www.nanotec2009.com/Ita/Homeita/Homeita.html.

private, can reach the targets in Nanotechnology and exceed the threshold of a new technological era.

Even if this is not the most suitable “place” for discussing things about the Nanotech payback, it is important to mention that some products derived from nanotechnology (the so-called "nano-related products") are already commercially available. A recent U.S. survey has identified about 800 nano-related products. This market was estimated in 2007 around 147 billion dollars and 310 billion dollars in 2008. Nanoelectronics is the “lion”, but there are also most common products such as cosmetics, sporting goods, clothing, paint, surface treatment. Once developed the technology, production costs drop dramatically and the further uses of nanotechnology will be extremely vast. Also considering the possibility that the artefacts could be self-replicating and their very small measures could allow an extremely “easy” – which does not necessarily mean cheap - or space-saving transport.

At this time to discover who is the enemy is essential, but first of all I want to mention an important division of creatures that **Daniel C. Dennett**[54] did in his book “Kinds of Minds”:

Firstly there was the Darwinian evolution. Many bodies were generated blindly, through more or less arbitrary processes of genetic recombination and mutation. In the field only the best projects survived. We will call its inhabitants Darwinian creatures[55].

Then, among these new creations, some, whose project had some properties of phenotypic plasticity, stood out: this means that individual organisms were not fully designed from their birth, some elements of their project could be adjusted by events occurring during the test field. We call this subset of Darwinian creatures Skinnerian creatures, since this operant conditioning is not only analogous to Darwinian natural selection, but it is an extension[56].

A better method involves an initial selection of all possible behaviours or actions, so that really stupid moves are discarded before being played in “real life”. The beneficiaries can be called Popperian creatures because, as Karl Popper said, this improvement project “enables our hypotheses die in our place”. Unlike Skinner merely creatures, many of which survive only because their first moves were successful, the Popperian creatures survive because they are smart enough to take, as a first step, better than random[57] initiatives.

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[54] **http://en.wikipedia.org/wiki/Daniel_Dennett**

[55] Cfr. *“Kinds of Minds: Toward An Understanding Of Consciousness”* Daniel C. Dennett – Basic Books, New York, 1996. http://www.questia.com/PM.qst?a=o&d=37063739.

[56] Ibidem.

[57] Ibidem.

One of Darwin's fundamental insight was that, although it is expensive to create a project, copy of existing projects is cheaper; in other words, do a completely new design is very difficult, but adapting old projects is relatively simple. We call this sub-sub-set of Darwinian creatures "Gregorian creatures". As an instrument is well designed (the greater the information embedded in its manufacture) the greater the potential intelligence that it gives to its user. Among the most important tools, as the famous psychologist R. Gregory stresses, there are what we call tools of the mind: the words. Words and other instruments of mind give a Gregorian creature internal environment that allows them to build generators and verifiers of moves increasingly sophisticated. Gregorian creatures take a big step forward towards a human level of mental agility, as they use the experience of others, taking advantage of the wisdom inherent in the mental tools invented, perfected and handed down by others, so they learn the best way to reflect on what they should think about the next move - and so on - generating a series of levels of internal reflections without a fixed or distinguishable limit[58].

It is understandable that the definition of Gregorian creatures can be associated with humans or, possibly, with some species of monkeys (able to use "intellectual tools", somehow) and with an **Artificial Intelligence**[59]; but in which category can we identify, for example, a self replicating nano-robot? It is plausible the inclusion of that kind of robots in the group of Skinnerian or Popperian creatures taking for granted their incapacity to use such artefacts as "intellectual tools", or, more generally, "culture".

If we imagine any type of nanotechnological weapon (bacteriological, chemical, robotic,…) in the wrong hands, the consequences could be really disruptive. We breast two enemies:

- The first is the nanotechnological "product" (that could be an artifact, a virus or a molecule, etc.) that can be considered a Skinnerian or a Popperian creature (it depends on the technological level). Surely it is not a simple weapon due to its swarm-like destructive capability but, above all, adaptive effectiveness and (possible) self-replication abilities. These last two characteristics typical of a Nano-weapon (as mentioned before), will be very dangerous and make this kind of threat one of the most difficult to counteract.

[58] Cfr. *"Kinds of Minds: Toward An Understanding Of Consciousness"* Daniel C. Dennett – Basic Books, New York, 1996. http://www.questia.com/PM.qst?a=o&d=37063739.
[59] **http://en.wikipedia.org/wiki/Artificial_Intelligence**

Moreover, We should not forget that extremely small dimensions permit easy smuggling, implying a greater difficulty in finding and tracking.

A low production cost, when this kind of technology is sufficiently developed, has also to be envisioned.

- The second enemy is the agency, both public or private (terrorist organization, team of scientists,…), or a person (a terrorist, a dictator, a fanatic,…) that can use or gain possession on nanotechnological weapons/artifacts … showing (or hiding) evil intentions.

This doubling of the enemies requires a more concrete and precise action of both regulations and supervisors: laws – both at national and international level – need to be (and should be) aimed at the protection of nanotechnologies, scientists and all the agencies correlated to avert any kind of evil intent and to make safe all the phases of R&D and use of Nanotechnologies. Supervisors could and should control not only the research programs but also researchers, agencies and the respect of the regulations. For that reason decision makers and laws, firstly, have the task of managing and regulating both nanotechnology and those who might benefit in large-scale.

Is this possible ? Is it even desirable ?

At the moment we don't have the capability, agreements and (probably) willingness at international level to develop a regulation and a control system able to monitor this kind of technology so important and multifaceted. Considering the political systems and the actual balance of power, could we ever reach the level of control mentioned above? The only system to achieve and sustain both R&D and Supervisors and that can legislate about Nanotechnology seems to be a Totalitarian Global Regime. This, logically in itself, is another kind of "threat" which implies a great freedom limitation for the mankind. In this case the problem of "nanotech control" should be considered solved….but another, and bigger problem is cast over all people so that the remedy might be worse than the problem.

There are a lot of examples of how nanotech could be used. Those examples are carried out in science fiction products (movies and novels) and show us both positive and negative exploitation, both enemies and friends. What I believe it is important to underline is the fact

that even if those movies and novels are quite far in the past, now are really close to the present.

In 1881 the Russian writer **Nikolai Leskov**[60] wrote a book on Levsha, Russian tradesmen who wrote texts that could be seen only through a microscope that magnifies 5,000,000 times. These microscopes are now used in nanotechnology.

The work of fiction of **Robert Silverberg**[61] "How was the past when he flew away" (1969) describes nanotechnology used for the construction of stereo speakers, with a thousand speakers per square inch.

Michael Crichton's[62] novel "**Prey**"[63], was one of the first books whose main theme revolves around nanotechnology to reach a mainstream audience, is a story of warning regarding possible risks of nanotechnology development.

Nanotechnology appears several times in the television series "**Stargate SG-1**"[64] and "**Stargate Atlantis**"[65], in the form of replicants and Asuriani respectively. In Stargate Atlantis a nanovirus terrifies with visions his victims before killing them. In **"Star Trek: The Next Generation**"[66] self-replicating nano-technology (called "nanites") is used extensively for many applications, starting from medicine. There are also a lot of other movie examples ("**I robot**"[67], "**G.I. Joe**"[68], etc.): with the classic "mad doctor" character which uses new nanotechnologies in his experiment; with the evil actor with futuristic nanoweapons; with a ultramodern setting in which robots, A.I. and nanotechnology are in ordinary usage.

However mankind has always dreamt about many things (propelled flight, the conquest of the Moon, …) that initially seems to be too far in the future and too unreachable to be believable. Those things, later, were done! Could be the same for Nanotechnologies?

Are Novels and Movies preparing us and clearing the cultural ground for technological discoveries which will drastically change human life?

[60] http://en.wikipedia.org/wiki/Nikolai_Leskov
[61] http://en.wikipedia.org/wiki/Robert_Silverberg
[62] http://en.wikipedia.org/wiki/Michael_Crichton
[63] http://en.wikipedia.org/wiki/Prey_(novel)
[64] http://en.wikipedia.org/wiki/Stargate_SG-1
[65] http://en.wikipedia.org/wiki/Stargate_Atlantis
[66] http://en.wikipedia.org/wiki/Star_Trek:_The_Next_Generation
[67] http://en.wikipedia.org/wiki/I_Robot
[68] http://en.wikipedia.org/wiki/G.I._Joe:_The_Rise_of_Cobra

3 Misuse of Nanotechnology.

I have asked to myself some questions trying to better understand how, nowadays, Nanotechnology - with all its applications and consequences - can threaten humankind; in which ways Nanotech could be concretely a danger and an existential risk. In this chapter. I have tried to fill my doubts selecting the following examples - of what “Misuse of Nanotechnology” could be - based on different distinctive features, close to the common feeling of threat (probably influenced by the Western ideas and perceptions) and to some recent events.

The first and the second scenario have in common the period (now) and the “players” (Nations) but analyze different settings: a dictatorship coming up and a dangerous arms race. The third take into consideration an actor different form a State (a Company or an Agency).

SCENARIO 1 –

> Let us imagine a world with the present socio-economical-political balance, with an unopposed superpower and developing countries, with a growing difference between developed States and the “Third World”, with a lot of dangerous areas in which war is the normal condition, with a great ideological opposition between east and west Countries. In this kind of scenario, the here and now, we can easily imagine a great nanotechnonolgical development in medicine and robotics which, for example, makes the molecules construction and deconstruction simple. This growth has brought the manipulation capability of the molecules, the chemical-biological ability of making nanorobots both for people’s health and ecology. We can imagine news on magazine and TV, research programmes and public foundings for institutes and teams of scientist. We can also forecast an unprepared leadership (decision makers

and politicians) who tries to "make do" (but with no relevant results) because of the great and diversified use of nanotechnology and also due to the fast expansion and application of the different branches of nanotechnology's results. This leads to a major lack of legislation and coordination among Western Countries.

In this condition it could be quite easy for a dictator, with economic possibilities, to obtain information, technologies and scientist, which lead him to reach his evil nano-goals. This means that, with a relatively small and cheap technology, a terrorist organization or a single person could hijack or modify a self-replicating nanorobot turning it into a dangerous weapon. We may assume that an absolutist regime is able to get hold of a nanorobot capable of deconstructing **carbon dioxide**[69] (CO_2) molecules: thus splitting into **oxygen**[70] (O) and **carbon monoxide**[71] (CO). This last molecule is an important metabolic poison - odourless, colourless, tasteless – and, in contact with the **haemoglobin**[72] of human blood, forms a stable compound called **carboxyhaemoglobin**[73]. This latter causes poisoning, for which the only effective treatment is the full blood transfusion[74]. The energy spent by this kind of metabolic nanorobot could be taken from the human body (for example using sugar or cellular **ATP**[75] to draw enough power to support themselves). It should be stressed that this poison affects all living beings with haemoglobin-based blood (thus also cows, pigs, horses, chickens, etc.)…but we are considering an absolutist regime and a period of war (ecologic or counter-resources) in which it could be useful to strike enemy's resources. After that there is the step (surely long and complex) of converting the metabolic nanorobot in a self-replicating weapon capable of self-diffusion in a well defined indoor space (e.g. a room, a floor of a skyscraper, etc.). Thus the threats of the probable attacker and the negotiations begin, lengthening the time because Western States will not give in on demands of a dictatorship or a terrorist group. This arouses the wrath of the dictator/fundamentalist, who unleashes the weapon against his enemies, killing people and animals on entire continents. An unprecedented disaster.

[69] **http://en.wikipedia.org/wiki/Carbon_dioxide**
[70] **http://en.wikipedia.org/wiki/Oxigen**
[71] **http://en.wikipedia.org/wiki/Carbon_monoxide**
[72] **http://en.wikipedia.org/wiki/Hemoglobin**
[73] **http://en.wikipedia.org/wiki/Carboxyhemoglobin**
[74] Cfr. **http://en.wikipedia.org/wiki/Carbon_monoxide_poisoning**
[75] **http://en.wikipedia.org/wiki/Adenosine_triphosphate**

SCENARIO 2 –

This second scenario can start in few years since now. After the SART 2 signed between USA and Russia on April 8th , 2010 (which establishes a ceiling of 1550 operational nuclear warheads and a maximum of 800 vectors for each of the two superpowers; the ten years treaty also provides new mechanisms for peer review of its compliance), there might be another arms race. Assuming that only a little group or a single highly technological developed Country can reach the goals of Nanotechnology (especially in robotics, biology and electronics) we can read on websites the discontent, the envy, the concern of the others States.

In that period of great astonishment some specialists will ask: how has that State been able to do that? How much has he spent? And the population, in general, could ask what is that State able to do now? Are we in danger? But in the same moment other people (as decision makers, business people, entrepreneurs…) will surely try to better understand the new political/economical situation using diplomacy and economic trades to have the possibility of duplicating the technology of the "nanotech" state. The negotiation could be very long - surely an intelligence activity with intent to rob / steal the technology would be faster, but with much more negative aspects like costs and risks for international security of such an operation - in the future timeline also because this innovation is really pervasive and with a lot of implementations in medicine, material engineering, robotics, biology, etc.. In this future scenario when that single state is outpacing the "superpowers" in economy, industry and research programmes without giving any information or patent to some other foreign company, taking for himself the knowledge and the know-how, a great chaos emerges: not only the great technological-industrial disequilibrium is shown but also a high fear about the Nano-weapon capability of that state which has created the suspect, with his behaviour, of doing unheard of before R&D and other plannings in great secret.

The "nanotech" state will do anything to maintain the primacy in Nanotechnology but others will call for more security and certainty. All the states that have failed to achieve the same level of technology will seek to reach the goal of Nanotech becoming partners of the rich State. But in vain. The first who hits with the greatest density of nano-penetrating forces in the shortest time may gain an irreversible advantage. The "first strike policy" could be seen as a viable solution by some

decision makers and, in this case, even a single state could trigger a preemptive nuclear war for fear of being crushed at a later time when the Nanotechnology is sufficiently developed. After an atomic attack surely the nanotech State will not feel helpless. It will use what is in his power to defend itself, its population and its interests, by fighting back.

Now everything could happen: either diplomatic negotiations leading to peace, or a nano-weapon-enabled retaliation with drastic conclusions. However, after a nuclear-nanotech exchange, damage to persons and property would be considerable.

SCENARIO 3 –

In the third scenario I want to underline that not only Nations could be stakeholders but also groups, terrorist associations, multinational companies, etc.. We could easily imagine that a rich, powerful, developed and unscrupulous multinational Company with a private R&D team of scientist and laboratories, could develop research in Nanotechnology.

In the same way it is believable that the stakeholder mentioned above, in the future, could be the first to reach the goal of nanotech specially in (1) chemical matters and (2) robotics. At this point groups, terrorist associations, multinational companies, etc. will surely implement nanomaterials, nanochips, nanobulk etc. in their products… and more!

Patents and products would be sold to the highest bidder, then new trades and markets would be created. In few years we would see a new era of technologies and trade:

> «with molecular manufacturing, international trade in both raw materials and finished goods can be replaced by decentralized production for local consumption, using locally available materials. The decline of international trade will undermine a powerful source of common interest. Further, (3) artificial intelligence will displace skilled as well as unskilled labor. A world system based on wage labour, transnational capitalism and global markets will necessarily give way. We imagine that a golden age is possible, but we don't know how to organize one. As global capitalism retreats, it will leave behind a

> world dominated by politics, and possibly feudal concentrations of wealth and power. Economic insecurity, and fears for the material and moral future of humankind may lead to the rise of demagogic and intemperate national leaders.»[76]

These three hypotheses (1: chemical, 2: robotics, 3: artificial intelligence) by M. A. Gubrund converge in letting us to ponder how Nanotechnologies could cohabit with globalisation, wage labour world system and transnational capitalism. Poor countries could become poorer, some scientists claim that we will soon see a new phenomenon called "nano-poverty"[77], and the economic stability of developed countries could waver: some powers could have not enough founds, primary resources or laboratories/researchers to improve rapidly his Nanotechnology.

A mined international trade doesn't help a correct diplomacy especially when nanotech gives surrogates of raw materials to a state till then poor of resources. Every state then closes in itself, and looks only his little "garden" thus bringing back to an historical period similar to the feudal age with a poor social and international balance.

In this kind of situation it seems easy to forecast widespread local wars (especially concerning the property of territories, old scars never healed, etc.) and social problems. A big pace for technology but a step back for societies. Some would argue that these three examples are not an "existential risk": the first could be a great attack, the second could be a world war and the last an a very deep economic depression. All those things are surely dangerous for a lot of people but not a risk for the mankind. Furthermore, everything of this has already happened and we survived.

However considering the examples above like premises, and bearing in mind the complexity of the technologically innovative phenomenon, one must uphold certain number of not benign consequences, which, mutually interacting in ways now unforeseen, may cause a spiralling concern in a socially destructive sense and likely to cause finally, with a reasonably high probability, a result of such a level as to be "lethal" or seriously debilitating in a non-temporary way to human population as a whole, thus classified as existential risk.

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[76] *"Nanotechnology and international security"* – M. A. Gubrud, University of Maryland, College Park, MD 20742-4111. http://foresight.org/Conferences/MNT05/Papers/Gubrud.

[77] Cfr. *"Nanotechnology and the developing world"* – F.Salamanca-Buentello, D.L. Persad, E.B. Court, D.K. Martin, A.S. Daar, in PloS Medicine, April 2005,2.
http://www.plosmedicine.org/article/info:doi/10.1371/journal.pmed.0020097

4 Conclusions: how we can reduce the "Existential Risk".

What kind of world do we wish to inhabit and leave to following generations? Our planet is in trouble if current trends will continue in the future: environmental degradation, extinction of species, rampant diseases, chronic warfare, poverty, starvation and social injustice. Not necessarily suffering and despair are humanity's fate. We have within our grasp the technology to help bring about great progress in elevating humanity. The nanotechnicnologic era will be fundamentally different from the era in which nuclear weapons were developed and came to dominate the possibilities for global violence.

The bombed-out cities of the Second World War, and the nuclear holocausts of our imagination, have persuaded rational minds that there can be no expectation of a meaningful victory in total war among states armed with hundreds of deliverable nuclear weapons. From that point of view, war is obsolete, at least direct and open war between great powers[78].

Nanotechnology could carry this evolution to the next step, also thanks to the different organizations which are working to a concrete and safe development of Nanotechnology: the **Foresight Institute**[79]; the **Center for Responsible Nanotechnology** (CRN)[80], a non-profit organization, formed to advance the safe use of molecular nanotechnology; **The Nanoethics Group**[81], a non-partisan and independent organization focused generally on the ethical and social implications of nanotechnology; etc..

[78] Cfr. *"Nanotechnology and international security"* – M.A. Gubrund - University of Maryland, Colege Park, MD 20742-4111. http://foresight.org/Conferences/MNT05/Papers/Gubrud.
[79] **http://www.foresight.gov/**
[80] **http://crnano.org/**
[81] **http://www.nanoethics.org/**

> «Nanotechnology promises both great opportunities and risks. New technologies offer unique prospects of curing the world's age-old intrinsic defects and pushing globalisation to its extreme. At the same time, we must be aware of Nanotechnology's potential to engender dangers never before encountered. What is most disquieting is the uncertainty of possible implications to the vulnerable domain of national security and defence. Very few publications and studies have been issued on this particular issue, and some of the assumptions and conclusions of those that have might still be speculative.»[82]

For that reason, several precautions can be helpful:

a. We need a defensive system more than we need an offensive one.

This means that all the research programmes could or should be focalized on safe Nanotechnology in every subject (medicine, biology, chemistry, robotics….and weapons). This strategy is the so-called "differential technological development" (proposed by transhumanist philosopher Nick Bostrom) in which societies would seek to influence the sequence in which emerging technologies developed. On this approach, societies would strive to retard the development of harmful technologies and their applications, while accelerating the development of beneficial technologies, especially those that offer protection against the harmful ones.

> «Trying to retard the implementation of dangerous technologies and accelerate implementation of beneficial technologies, especially those that ameliorate the hazards posed by other technologies. In the case of nanotechnology, the desirable sequence would be that defence systems are deployed before offensive capabilities become available to many independent powers; for once a secret or a technology is shared by many, it becomes extremely hard to prevent further proliferation. In the case of biotechnology, we should seek to promote research into vaccines, anti-bacterial and anti-viral drugs, protective gear, sensors and diagnostics, and to delay as much as possible the

[82] *"The security implications of Nanotechnology"* – Rapporteur: Lothar Ibrügger – NATO 179 STCMT 05 E. http://www.nato-pa.int/default.asp?shortcut=677.

development (and proliferation) of biological warfare agents and their vectors.»[83]

Something analogous is needed by nanotech. Against Nanothreats seems logical to imagine, in a near future, a global nanotech immune system or an “active shield”. This would be ideally desirable and perfect. But we don’t live in a idyllic world and surely if there is a lot of people willing to develop a defensive nanotech there could also be some others (with evil intentions) trying to develop an offensive one. This is due both to scientific or technological reasons and to economic ones…but also to human nature, which sadly finds shortcuts to power through aggression. In my opinion a solution could be the use of armed forces: that means that defensive Nano-research program, which has implications in weaponry or military affairs, should be controlled or supervised or carried out in collaboration with military engineers and researchers. In this case high ranked soldiers with an elite-team of colleagues would perform the office of guarantor for a safe, controlled and protected use of nanotechnology in a prospective vision of a defensive use of that kind of technology. At the hierarchical structure mentioned above could be delegated some authority in the administration of research programs, but political decision makers should have the capability of supervising and drawing appropriate conclusions.

I understand that this could be seen by many as a danger for the democratic system allowing the military to control or otherwise “infiltrate” a very important branch of research. It should be remembered, however, that something similar happened during the atomic bomb developing period in the USA.

I do not deny that there are some relevant differences that have to be considered:

- First, that “atomic bomb project” has only military implications while Nanotechnology could have, as said before, many applications.

- Second, that "cold war" period was marked by the confrontation between the NATO forces and the Warsaw Pact, that means that military research experimentation and development at that time were probably much more "tolerable" for civilians.

[83] *“Exixtential Risk – Analyzing human extinction scenarios and related hazards”*; N. Bostrom - published in the Journal of Evolution and Technology, Vol.9, March 2002.

- Third, atomic bomb, unlike nanotechnology, was a purely offensive weapon.

Not denying such important differences, what I want to propose is that the starting point for further discussions should be that defensive nanotech research could be fostered and cared by militaries, since a military supervision, and in this way the governmental one too, undoubtedly would reduce the risk of leaving such technology in dangerous and unreliable hands. Furthermore a government responsibility in this direction could lead to higher speed and accuracy not only in dealing with this topic but also regulating it. This until it has reached a balance and common rules that protect the safety of mankind, the researchers and the nanotechnology itself.

b. It should be noted also, in general terms, the absence of rules in international and Communitarian law that expressly has to govern nanotech applications. Nevertheless there are general principles that can find useful application in the relevant field such as, for example, the principle of prevention, of prior environmental impact assessment and the precautionary principle (which implies a sort of reverse burden of proof, by requiring anyone who intends to carry out certain risky activities - and not against potential victims - the burden of proving that this activity does not create a "serious and irreversible" threat of harm for human environment and habitat, and the burden of adopting appropriate measures to dispel potential risks related to or resulting from the activity in question). There is also, in terms of international law, an agreements source, the *Cartagena Protocol on Biosafety* (signed at Montreal January 29, 2000), supplementing the *Convention on Biological Diversity* (Rio de Janeiro, June 5, 1992), which has some relevance for the investigation. The more targeted ones the legal and policy guidelines made by the EU, which are well placed to identify the main legal issues raised by nanotechnology not only in terms of protecting health and the environment: the EU documents bring out the distinctive features concerning the protection of confidentiality, protection of intellectual property rights, international cooperation in this area, etc.. In the light of extensive public consultations and favorable feedback of the EU Council[84], the Commission adopted, in June 2005, a specific action plan in nanotechnology, entitled *"Nanoscience and nanotechnologies: An action plan for Europe 2005-2009"*, which defined a set of

[84] Cfr. Plenary Meeting of September 24, 2004.

articulated and interconnected actions aimed at giving effect to the priorities identified in the notice[85]. Finally turning to examine the activity carried on by the so-called "standards bodies" may remember that in early 2005, at the instigation of the British Standard Institution (the national standards body of the United Kingdom), the Central Secretariat of the **International Standardization Organization** (ISO)[86] asked its members to consider the opening of a new branch on the regulatory nanotechnology (ISO/TS/P199[87]). This initiative, in essence, aims to establish a technical committee (**ISO/TC229**)[88] that deals with standardization in the field of nanotechnology, with specific reference to the classification, terminology, nomenclature, basic metrology, characterization (including calibration and certification), environmental aspects and risk management. In USA the National Nanotechnology Initiative (**NNI**[89]) coordinates the policy of 25 government agencies, including 13 that have budgets for nanotechnology research and development. It is widely shared, in terms of regulations and laws, the opinion that we (both Europe and USA) are a step behind the nanotechnology innovations and, ideally, governmental actions should be preventive rather than reactive. That's why there is no common view on the different aspects of the matter even on classification and terminology. There is no common policy or guideline about international Nano-research and Nano-security.

It would be desirable not only a guideline but also a series of multilateral agreements among developed countries, that leads to an increment only in research programmes relating to "useful and safe" nanotechnologies: defensive nanotech, pro-environment

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[85] In particular, the Action Plan expresses the Commission's desire to increase budgetary allocations in favor of nanotechnologies in the future Seventh Framework Programme for research, technological development and demonstration, covering the period 2007-2013 (See COM (2005) 119 of 6 April 2005, OJ No. C125 of 24 May 2005, p. 12.) by strengthening the interdisciplinary research across the entire cycle of creation, transfer and use of knowledge, and proposing a specific support for nanoelectronics. The Commission also intends to strengthen its support to research concerning the potential impact of nanotechnology on human health and the environment (with specific reference to the so-called nanoparticles and nanotubes), through the implementation of the toxicological and ecotoxicological studies as well as the development of methodologies and tools to monitor and reduce exposure to potentially harmful agents, in particular in the workplace (such as research labs). These priorities are added, finally, by encouraging support for nanotechnology in areas considered essential for the competitiveness of the European community, such as medicine, chemistry and space.

[86] **http://www.iso.org/**

[87] available at: http://www.din.de/sixcms_upload/media/1345/ISO-Umfrage_Establishment_of_ISO_TC_229_Nanotechnologies_Vote_until_2005-05-27.pdf

[88] **http://www.iso.org/iso/iso_technical_committee?commid=381983**

[89] Significant legislation governing the NNI (**http://www.nano.gov/**) includes the 21st Century Nanotechnology Research and Development Act (P.L. 108- 53). Interagency coordination is managed by the Nanoscale Science, Engineering, and Technology Subcommittee within the National Science and Technology Council. For a good description of the NNI, see, National Science and Technology Council, *The National Nanotechnology Initiative: Supplement to the President's 2007 Budget*, Washington D.C., July 2006. Available at http://www.nano.gov/NNI_07Budget.pdf .

nanotech, medicine, etc.. **Dr. Jürgen Altmann**[90], one of the most prominent researchers of military nanotechnology, suggests that «the technologically leading nations should exercise unilateral and co-ordinated restraint with respect to military Nanotechnological activities, in particular de-emphasising or avoiding those that could lead to offensive uses.»[91] Together with this, verification mechanisms should be reinforced and developed both for Nanotechnology and by Nanotechnology: greater controls on research laboratories and programs could be delegated to the armed forces (which would in turn be controlled by the decision makers or political bodies in charge) so as to ensure compliance with the rules and a proper experimentation on pre-set areas (see the previous point at pag. 23-24).

c. Related to this problem, there is an ethical discussion about the danger of "autonomous", autopoietic developing technology, which increasingly tends to become detached from the real needs of humanity. One might ask whether nanotechnology match this pattern of exaggeration of industrial development. In terms of bioethica, the answer may be the traditional one: technology development should be directed to specific objectives and personal and social values consistent with the safety and individual and collective wellness, in the democratic context promoting a social participation in defining the objectives and monitoring results. Even the nanotechnology industry should comply with these requirements. Particular bioethical sensitivity should be given to the possible production - for example - nanotechnology products inclusive of human genes (e.g. Artificial **chromosomes**[92]; polymer nanocapsules enclosing and delivering human genetic products) in relation to the "indications" of their use, and not only the adherence to the rules of international patenting in their production. At the same time it would put bioethical questions concerning the submission of such structures on the side of advertising and commercial offering to the consumer, because it would be necessary to inform the latter of the origin of biological material eventually becoming part of the building itself, and leave it free to exercise his choice coherently with his/her personal ethical sensitivity. The considerations above are all right and deep, but now it is relevant and

[90] See *"Millimetre Waves, Lasers, Acoustic for Non-Lethal weapons? Physics analyses and Inferences"* – J. Altmann; 2008, Deutsche Stiftung Friedensforschung; available at: http://www.bundesstiftung-friedensforschung.de/pdf-docs/berichtaltmann2.pdf . For information about the author see **http://www.isodarco.it/courses/andalo05/andalo05-papers.html .**

[91] Cfr. *"The security implications of Nanotechnology"* – Rapporteur: Lothar Ibrügger – NATO 179 STCMT 05 E. http://www.nato-pa.int/default.asp?shortcut=677.

[92] **http://en.wikipedia.org/wiki/Chromosomes**

essential to ask questions on ethical development of nanotechnology dangerous or potentially destructive (especially in weaponry). There are Ethic problems and questions not only in the experimentation and tests phase but also in the use and production one. The use of nanoweapons, self reliant robots and bio-nanotechnology can lead not only to the mismanagement of themselves but also to an even more sophisticated research by the developed nations in order to be considered in the international arena or to be considered only "fashion". Is that right? I think that a deep and intense discussion about that in international summits should be done. It has to be fast and give the tools (laws and agreements) to nations, scientists, research programs and soldiers to operate in the most correct and safest way. Nations must learn to trust each others enough to live without massive arsenals, by surrendering some of the prerogatives of sovereignty so as to permit intrusive verification of arms control agreements, and by engaging in cooperative military arrangements. An integrated international security system, in which all nations can identify themselves and in which respect and collaboration are cornerstones, could be a solution.

> «The nanotechnic era will be fundamentally different from the era in which nuclear weapons were developed and came to dominate the possibilities for global violence. […] Nanotechnology will carry this evolution to the next step: deterrence will become obsolete, as it will not be possible to maintain a stable armed peace between nanotechnically-armed rivals. The implications of this statement stand in sharp contradiction to the traditions of a warrior culture and to the assumptions that currently guide policy in the United States and in its potential rivals.»[93]

That is why Nanotechnology is a candidate leader to a **Revolution in Military Affairs (RMA)**[94] and that is why we have to expand our way of thinking not only the everyday life things but also wars, threats, laws, ethical problems, etc.. This to avoid disasters and dangers, and to let the human beings evolve in a safer and more civil way.

[93] *"Nanotechnology and international security"* – M.A. Gubrund - University of Maryland, Colege Park, MD 20742-4111. http://foresight.org/Conferences/MNT05/Papers/Gubrud.
[94] **http://en.wikipedia.org/wiki/Revolution_in_Military_Affairs**

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Ce.Mi.S.S.[95]

The Military Centre for Strategic Studies (Ce.Mi.SS)[96] is the body that manages, within and for the Italian Ministry of Defence, the research on issues of strategic nature.

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[95] **http://www.difesa.it/smd/casd/istituti+militari/cemiss last visit 2010 Nov 09**
[96] **http://en.wikipedia.org/wiki/Italian_Military_Centre_for_Strategic_Studies**

Ce.Mi.S. S.

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[97] http://it.wikipedia.org/wiki/Centro_Militare_di_Studi_Strategici

Information systems are frequently exposed to various types of threats which can cause different types of damages that might lead to significant financial losses. Information security damages can range from small losses to entire information system destruction. The effects of various threats vary considerably: some affect the confidentiality or integrity of data while others affect the availability of a system. Currently, organizations are struggling to understand what the threats to their information assets are and how to obtain the necessary means to combat them which continues to pose a cha