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BOOK REVIEW

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Koos van der Bruggen

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Jürgen Altmann, Military Nanotechnology. Potential Applications and Preventive Arms Control. Routledge London/New York 2006.

Most technologies have their roots in civil technical universities and in research laboratories of private enterprises. But in history there is hardly any technology that has not been used – or abused – for military purposes. A well-known example is nuclear technology. The discoveries of Einstein and others in the first half of the twentieth century were applied to develop the atomic bomb. Robert Oppenheimer and other famous physicists were involved in this so-called Manhattan-project. The main reason for their participation was the fear that Nazi-Germany would develop its own nuclear weapon.

After the Second World War the world became divided during the Cold War, which would last for more than 40 years. One of the consequences was an arms race between the United States with its allies and the Soviet Union with its allies. Scientists and engineers played a major role in this arms race. All kinds of technical and scientific research was not only – and often not even in the first place – directed at civil use, but also at its military value. Nuclear technology, biotechnology, information technology: military or military relevant (dual-use) applications were prominent on the agenda.

K. van der Bruggen (✉)
Faculty of Law, Leiden University,
P.O. Box 9520, 2300 AA Leiden, The Netherlands
e-mail: j.j.g.van.der.bruggen@law.leidenuniv.nl

The end of the Cold War was not the end of this military involvement in research and development. That is clearly shown by Jurgen Altmann in his book *Military Nanotechnology. Potential Applications and Preventive Arms Control*. Since the 1980s, but with considerably more promises and results in the 1990s and in this first decade of the twenty-first century nanotechnology has become a new focus of scientific and technological research. Altmann gives a short description of this early history and of the promises and risks of this "next industrial revolution." Almost from the start it was realized that nanotechnology (NT) could have far reaching consequences for warfare and the armed forces. Well-known authors on NT as Drexler and Joy have paid attention to possible military applications of NT. During the first workshop of the National Nanotechnology Initiative (NNI) on societal implications of NT seven possible applications for "national defence" are given: continued information dominance through advanced electronics; more sophisticated virtual reality systems; increased use of enhanced automation and robotics; higher performance (lighter weight, higher strength) in military platforms; improvements in chemical, biological and/or nuclear sensing; design improvement for nuclear non proliferation monitoring; combined nano- and micromechanical devices for control of nuclear defence systems.

The possible applications are very divergent. For anyone who knows a bit of nanotechnology this should not come as a surprise. As Altmann writes: when working at the nanometre scale "the borders between the disciplines physics, chemistry, biology vanish, including their sub-, intermediate and applied fields."

The merit of the study by Altmann is that he presents in a very systematic way the possible military applications of NT. He does so by starting with an overview of nanotechnology. He describes the principles of nanotechnology and he elaborates the possible applications in different fields. He is clearly discerning realistic options from options that are very improbable, if not impossible from a scientific point of view. He stays close to "mainstream" science.

Not surprisingly the only remaining superpower, the United States, is putting most efforts in military applications of nanotechnology. In 2004 the Department of Defence funded more than 200 million dollars in NNI for research. Military nano research is carried out by various institutes and organizations. Most are directly linked to the Department of Defence (DoD), but military-oriented research is also done by universities. Outside the United States research is also done in military nanotechnology, but on a much more modest scale. In 2003 the US spent 12–16 times as much as all Western European countries together.

As said, the research projects are as divergent as the field of nanotechnology. Some examples of potential military applications can illustrate this: electronics, new materials, propulsion, vehicles, explosives, camouflage, sensors, conventional weapons, implanted systems, autonomous systems, bio-technical hybrids, small satellites, nuclear weapons. Reading about all these – and more – possible military applications can lead to rather pessimistic views on the future of our world. Even if only 10% of all potential applications would be realized, that would not make the world a safer place! And as Altmann only describes developments and technologies that in principle are realizable and that are already or in the nearby future will be issues of research, you can make a bet that at least 10% will be realized. Because of that it is necessary that as soon as possible military nanotechnology becomes part of talks and debates on arms control.

In the last part of his book Jürgen Altmann presents the criteria that should be applied in such a process of (preventive) arms control and in applying these criteria to the (possible) military applications of nanotechnology. He discerns three principles: adherence to and further development of effective arms control, disarmament and international law; maintaining and improving stability; protecting humans, environment and society. Altmann is conscientious and punctual in applying these criteria to each of the possible nanotechnological military products. He assigns values to each of them: is the application positive, negative or neutral from an arms control perspective? It leads him to a number of recommendations for preventive arms control action, to some confidence building measures and to recommendations for further research, especially in the more problematic areas. These are: small sensors, new conventional weapons, body manipulation, autonomous systems, small satellites and last but not least the field of chemical and biological weapons. In these fields he expects the most dangerous and destabilizing developments which should be prevented by arms control.

I conclude with two remarks. First: the approach of Altmann is strongly technology-oriented and much less related to political, strategic and military considerations that play a role in decisions to acquire nanotechnological weapons. Of course it is true that the overview by Altmann is based on research projects that are carried out in all kind of Defence and Army Institutes, but that does not mean that all these projects will result in production and procurement of weapons systems. That is to a great extent dependent on political, strategic and military considerations. And these same considerations are probably more decisive for the results of preventive arms control than potential technical applications and possibilities as such. To give an example: despite the destructive power of nuclear weapons these weapons were never forbidden by arms control or international law. Substantial reductions were only possible after the Cold War.

Second: Altmann derives the criteria for judging military nanotechnology from three arms control principles: adherence to and further development of effective arms control, disarmament and international law; maintaining and improving stability; protecting humans, environment and society. In fact these principles are deduced from the just war tradition. From a moral point of view it would have been interesting if military applications of nanotechnology would have been tested against just war principles such as the non-combatant principle (which calls for discrimination between military and non-military people) or the principle of proportionality (which asks for a proportionate relationship between the goals and the military means during a war). What applications of military nanotechnology fit or do not fit these criteria?

These remarks do not alter my judgment that Altmann has done an impressive job by presenting an almost complete overview of the possible military relevant applications of nanotechnology. He deserves praise for this exercise, if only because it is a warning for scientists against the possible unintended use that can be made of their research in the field of nanotechnology.