The Dual-Use Dilemma: Raising Awareness among the Academic and Scientific Communities in Central Asia and Eastern Europe

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Abstract

Dual-use dilemmas arise when the same scientific work can be used to do good or be misused, and it is unclear how to prevent misuse without foregoing beneficial applications. When it comes to chemical, biological, radiological and nuclear (CBRN) weapons and agent development, the number of related knowledge areas open to misused is almost impossible to gauge. The fast pace of technology evolution adds to the challenge.

In this paper, we present our CBRN export control projects to raise awareness among academic and research communities in Central Asia and Eastern Europe. They are implemented under the auspices of the International Science and Technology Center (ISTC) and the Science and Technology Center in Ukraine (STCU).

Keywords: ISTC, STCU, dual-use dilemma, CBRN agents, export control

1. Introduction

During the last few years we have witnessed the use of chemical weapons against the Syrian population and the threat of use of nuclear weapons by North Korea.

CBRN weapons are also widely known as "Weapons of Mass Destruction" (WMD) because of their potential for indiscriminate harm. Their development and manufacture require raw materials, specialized equipment and research, production and storage facilities, on the one hand, and knowledge, expertise and experience, on the other hand. These necessities are mostly dual-use: they have legitimate civilian applications but can also applied to build weapons. Concrete objects and artefacts are tangible. In contrast, knowledge, experience and expertise are intangible technologies. Scientific knowledge and manufacturing processes are particularly relevant to the acquisition of CBRN weaponry. Their widespread application for commercial purposes (e.g. nuclear power plants, biotechnology, pharmaceuticals, etc.) considerably increase the dual-use challenge.

Given the ever-increasing pace of innovation, the relevant scientific and professional communities are not always conscious of the potential implications for inadvertent or deliberate misuse of their work. Raising awareness about the dual-use dilemma is a relatively new educational

[1] https://www.parliament.uk/documents/post/postpn340.pdf (last access, 25 December 2017)

project that intends to avoid the misuse of science and technology.

In this context, the G8-Global Partnership Working Group made in 2009 a set of recommendations related to the spread of sensitive know-how worldwide, highlighting the importance to engage scientists in awareness raising activities[2].

To help the countries in Central Asia and Eastern Europe, we develop one Target Initiative for each region with different activities to engage members of academia in nonproliferation and dual-use export control initiatives.

The umbrella organizations for the Target Initiatives are:

- ISTC for Central Asia. Participating countries are: Armenia, Afghanistan, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan.
- STCU for Eastern Europe. Participating countries are: Azerbaijan, Georgia, Moldova, and Ukraine.[3]

The two Target Initiatives are running in parallel, allowing the interaction between participants in activities, such as the Train the Trainer program that will take place during 2018 and will gather professors from both regions.

Participating countries have different characteristics and varying degrees of development, which pose interesting challenges for the implementation of the Target Initiatives.

The involvement of the academics will clarify the regional approaches to CBRN risk mitigation and enable assessment of the measures already undertaken and identify gaps awaiting remediation.

Finally, while the primary focus of our project are scientists, we cannot ignore the linkages to other professional categories. On the one hand, the international community aims to control of CBRN through multiple and varied types of international legal instruments. On the other hand, technology transfers, for instance through trade and assistance programs, involve multiple actors. Not only should each actor category be familiar with the dimensions of CBRN proliferation prevention of direct relevance to it; it should also be aware of the responsibilities of other players. To this end, the project will not just target natural scientists, but also government officials, lawyers, economists, social scientists, etc. The interaction among research and professional communities, on the one hand, and the exchange of experiences and best practices, on the other hand, are two mutually reinforcing aims.

Before describing the projects proper, we offer background information about CBRN, the dual-use dilemma, and the export control regimes for dual-use goods.

2. CBRN agents

Each CBRN category covers a wide range of agents. They have different characteristics in terms of harmfulness and destructiveness in accidents or non-intentional and intentional releases. While the four categories are often presented as discrete units, reality is that their boundaries are fuzzy. The principal categories—biological, chemical and nuclear—are linked by two other distinct classes of agents, each of which unites certain characteristics that distinguish the principal categories (see Figure 1).

Biological weapons involve the development and dissemination of infectious, self-replicating microbial organisms. Chemical weapons refer to toxic chemical substances that directly affect their target through processes of poisoning. Nuclear weapons destroy their target primarily by means of blast and heat that follow the explosion induced by a nuclear reaction. Whereas biological and

[2] http://www.gpwmd.com/about (last access 29/1/2018)

[3] Georgia participates in both ISTC and STCU projects.

chemical agents may target humans, animals or plants, a nuclear detonation will besides life also destroy infrastructure and materiel on a large scale.

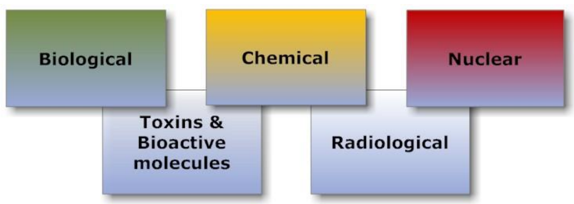

Figure 1: main categories of agents

In the gray area between biological and chemical weapons are toxins—poisonous substances produced by living organisms—and self-replicating particles, such as proteins and prions. Between chemical and nuclear weapons are radiological weapons, which poison their target through radiation. From the perspective of the dual-use dilemma facing scientists, professionals and academics, understanding the full range of possible agents in each of the categories is key to them appreciating their possible contributions to preventing the misuse of science and technology. Awareness of these weapon categories is often limited to so-called 'weapon-grade' agents, i.e. past and present agents developed for warfare purposes. Consequently, when confronted with questions about the prevention of proliferation, the immediate reaction will an expression of horror, accompanied by an exclamation that they do not engage in such work. Appreciation of the range of possible agents will enable scientists, professionals and academics to adopt safety and security measures in their workplace. As private citizens outside their workspace they can also participate in the public policy-shaping debates.

Biological weapons

Biological agents occur naturally. Most are benign and many actually live on or inside the human body. Some will become harmful only if the organism is weakened. Infants and the elderly always face heightened risk of infection. However, if an organism suffered a major insult (e.g., after an accident) or the immune system is compromised (e.g. undernourishment or living in extreme fear as in war situations) the most banal infectious agent may become lethal. Other pathogens may invade the body and overwhelm natural defenses. Some are potentially lethal (e.g., anthrax or smallpox); other ones may merely incapacitate under most circumstances (e.g., salmonella). Finally, certain pathogens are species-specific (e.g., smallpox and humans); other ones infect only animals (but may be zoonotic, i.e. they can become transferrable to humans under certain circumstances) or plants. In the past animal and plant diseases were developed to target the enemy's agriculture.

Chemical weapons

Chemical agents are poisonous substances that through their direct chemical action interfere with life processes. Just like biological agents, they can target humans, animals or plants. Certain agents are short-term irritants (e.g. lachrymators, sternutators, or emetics) or induce longer-term incapacitation[4]. Other ones vary in their degree of lethality, ranging from chlorine and phosgene to the class of nerve agents, which includes sarin and VX. Exposure to chemical agents can have long-term effects. Chlorine and phosgene may cause permanent damage to the respiratory system. A vesicant like mustard agent badly scars the skin through its blistering properties. Survivors of even low-level exposure to neurotoxicants may suffer permanent neurological damage.

[4] A final category, incendiary weapons, is also based on an intense chemical reaction, but they affect their target through flame or heat rather than through any poisonous characteristic. Incendiary weapons are not the subject of the present article.

Moreover, vesicants and neurotoxicants damage the victim's DNA and may thus harm future generations. Massive use of herbicides, defoliants or growth stimulators may permanently alter local ecologies and cause transgenerational damage in the offspring of people exposed to the agents. Such chemical agents do not occur naturally. Except for chlorine (which is an element, but still needs to be produced), they are compounds that are synthesized on industrial scale. Terrorists or criminals, however, may use commercially available toxicants or industrial chemicals as weapons. Acids may cause life-changing harm to victims; rodent poisons inserted into the food chain may cause severe economic damage. Captured liquid chlorine intended for water purification has been turned into weapons.

Nuclear weapons

Nuclear explosive devices use either nuclear fission or fusion (in combination with fission). A fission-based nuclear device uses high-enriched uranium-235 (HEU); a fusion-based system is fueled by separated plutonium-239. Uranium-235 is obtained in minute quantities (0.7 percent purity) through a complex extraction process starting with mined uranium ore, and subsequently purified. Fuel for a nuclear reactor is enriched to 3.5–5 percent. Weapons grade uranium requires a purity of over 90 percent. The conversion of low-enriched uranium into HEU for a fission bomb poses significant additional technical challenges. Plutonium-239 is a by-product of the irradiation of uranium-235 in a reactor and requires complex chemical separation to prepare it for a nuclear fusion reaction.

A nuclear detonation produces primarily blast and fire, which are also the main causes of destruction, as well as radiation, which is responsible for long-term health effects in survivors and their progeny and environmental contamination. In 1945 a fission and a fusion bomb were used against Hiroshima and Nagasaki respectively. Both events and the massive test explosions conducted during the height of the cold war placed nuclear weapons at the top rung of destructiveness. Nevertheless, the nuclear powers developed nuclear weapons of different sizes and with different yields, making them suitable for individual backpacks, artillery shells and rockets, as well as bombers and intercontinental ballistic missiles.

Toxins and bioactive molecules

Toxins are poisons produced by living organisms, including bacteria, plants and animals. They can also be synthetically manufactured. From a military perspective, the neuro- and cytotoxins are the most relevant categories. Neurotoxins are usually fast-acting poisons that block the transmission of impulses along nerves and muscle fibers, leading to numbness, muscular incoordination, confusion, headache, blurred vision and light sensitivity, convulsions, paralysis, and so on. Although many effects may resemble those from nerve agents, they do not result from the inhibition of acetylcholinesterase. Cytotoxins, in contrast, destroy cells and interfere with cell metabolism. They can impact on various type of tissues and impede digestion, respiration, or blood circulation. Symptoms range from irritation, over blistering and hemorrhaging, to death.

Among the toxins investigated for military purposes were ricin, saxitoxin, clostridium botulinum toxin, staphylococcal enterotoxin, trichothecene mycotoxins and aflatoxin. Most toxins, however, are difficult to produce on large scales and cannot be stored for prolonged periods. Even though they are much more toxic than nerve agents, they have mostly been used for individual assassinations. Ricin is an agent of interest to lone-wolf terrorists.

Among the bioactive particles are proteins and peptides. Proteins are complex sets of amino acids, which form the basic building blocks of life. Peptides are short fragments of proteins. They occur in the nervous and hormonal systems and are biologically active at very low concentrations. They help to control a variety of functions, including emotions, mood and fear, blood pressure, body temperature, sleep, consciousness, and so on. Bioregulators are potentially lethal but could also play roles as incapacitating agents. Under present circumstances, their release would be hard to detect, particularly since there would be no causative agent to detect despite an abundance of physiological symptoms.

Proteinaceous infectious particles or prions lack nucleic acid and are believed to be able to induce normal proteins to change shape and become harmful to the host brain or neuron cell. Consequently, they cause certain degenerative diseases of the nervous system. In humans, prions are responsible for the Creutzfeldt-Jacob Disease (CDJ) and Gerstmann-Straussler Syndrome. They also cause scrapie in sheep and goats, as well as bovine spongiform encephalopathy in cattle. Spongiform encephalopathies (named after the typical holing in the brain) are fatal.

Advances in nanobiotechnology and nanobioscience too, hold the potential for future synthetically developed agents that blur the distinction between biological and chemical agents. Presently, their threat potential is more associated with state-run programs than with terrorists.

Radiological weapons

Radiological weapons encompass any device intended to disperse radiological materials to radioactively contaminate persons, areas or infrastructure.

During the 1950s they were considered for battlefield use by the United States, but never entered mainstream military doctrine because of the development of tactical nuclear weapons for artillery and short-range missiles. They were also developed as a missile warhead for ballistic missile defenses with a view of disrupting the electronics of incoming missiles. In the late 1970s President Jimmy Carter was forced to cancel further development of the neutron bomb following widespread protests against their possible deployment in Europe. China, France and the Soviet Union also researched and tested enhanced radiation weapons. Today, radiological weapons are not believed to have been militarily deployed.

An explosive device is considered a likely means for terrorists to disperse the isotopes. A mass of less than 100kg of high explosives might suffice to disperse a small radioactive source of between 1 and 10 Curies; a much bigger one is believed necessary to spread tens or hundreds of thousands of curies. Efforts to model the impact of such detonations have been limited, and consequently the number of casualties and amount of damage an explosive radiological device might cause is hotly debated. According to one scenario, the detonation in a city center of a backpack dirty bomb of about 45kg with radioactive material used in cancer treatment is highly unlikely to produce any fatalities through radiation. A similar amount of explosives combined with 45kg of spent nuclear fuel rods loaded on a lorry may yield lethal radiation doses in a 5-600 mts range. There are also suggestions that larger devices might become so unwieldy as to reduce their attractiveness to terrorists. Yet, blast and projected debris are viewed as the most likely causes of death or injuries to persons closest to the detonation. Otherwise, people farther away from the detonation may receive a radioactive dose with minimal consequences. It has been noted that 'it is very nearly impossible to disperse radioactive material from an explosively powered dirty bomb in such a way that victims externally absorb a lethal dose of radiation from the source before they are able to leave the area.' People may suffer radiation harm if they are slow to evacuate scene of the attack, or in case of stealthy dispersal of the radioactive materials. With a larger bomb, the greatest health risks may come from the inhalation of radioactive dust and smoke particles (e.g. in or near a collapsed building) or from a downwind plume of contaminated materials.

The participating countries in our Target Initiatives have some history on the development of CBRN agents. Here some examples[5]:

- Kazakhstan inherited nuclear-tipped missiles, a nuclear weapon test site, and biological and chemical weapon production facilities when the Soviet Union collapsed. In its first decade of independence, Kazakhstan dismantled and destroyed Soviet weapons systems and facilities left on its territory and signed relevant international treaties.
- Following the collapse of the Soviet Union, Ukraine inherited a sizable nuclear weapons infrastructure. Its sudden possession of the third largest nuclear arsenal in the world left this newly independent country with a strategic decision on whether to return the weapons to Russia or become a nuclear weapon state itself. In the end, Ukraine, along with Kazakhstan and Belarus, decided to return their weapons and delivery systems to Russia and to join the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as a non-nuclear weapon state.
- Kyrgyzstan does not possess nuclear, chemical, or biological weapons programs, and is a member of relevant weapon control treaties and organizations.

  Kyrgyzstan inherited a large uranium mining and milling complex and several military-related industrial facilities when the Soviet Union collapsed. The uranium ore mines are in Min-Kush in central Kyrgyzstan, in Kadji-Say in the east, and at Tyuamuyin in the south. Kyrgyzstan is geographically situated near several countries of proliferation concern, making it a possible transshipment point for illicit trafficking in sensitive materials.

3. Export control instruments

No unified system of control mechanisms for dual-use technologies exists. An important is reason is that the technologies underlying the various weapon categories are fundamentally different. A second major reason is that the prohibitory regimes vary in defining the technologies, the scope of the prohibition and the degrees to which the regimes are verifiable. Furthermore, some regimes are founded in formal treaties; other ones are the outcome of UN Security Council resolutions; or they result from informal consultation and coordination arrangements. A final dimension is that some regimes are global, whereas other ones are regional. National laws and regulations will cover not only exports, but also internal transfers of controlled goods (i.e. from company to company, or sales and other forms of transfer to private individuals).

It should also be noted that certain technology transfers are governed by international and national regulations that focus on safety rather than security: they set standards on whether certain materials can be transferred or not and under which conditions such transfers may take place. They are usually part of air, land (road or rail), or sea transport regulations.

Embargoes—imposed globally by the UN Security Council, by regional organizations (such as the EU), or nationally—may prohibit the transfer of certain goods to specific countries for certain periods of time

[5] The information regarding the countries was extracted from: http://www.nti.org/learn/countries (last access, 20 January 2018)

if security circumstances warrant such measures. Usual reasons are armed conflict, gross human rights violations or material breaches of international treaties. The following paragraphs illustrates some of the most important international regulatory regimes. (The list is not comprehensive.)

Formal multilateral treaties

- The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (BTWC) was opened for signature in 1972 and entered into force in 1975. As of January 2018, it numbers 180 states parties. The treaty completely outlaws the development, production, and stockpiling of biological weapons (which it defines), and prohibits the transfer or any form of assistance, encouragement or inducement of anyone else to acquire or retain biological weapons. 'Anyone' covers both state and non-state actors. All states parties must enact national legislation that makes the international obligations applicable to legal and physical persons.
- The Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC) was opened for signature in 1993 and entered into force in 1997. As of January 2018, it has 192 states parties. The scope of the prohibition and demands on state parties are similar to that in the BTWC but its regulatory regime is much more specific. The treaty established an international body to oversee implementation, the Organisation for the Prohibition of Chemical Weapons (OPCW). States parties must submit annually (in some cases, according to shorter time frames specified in the treaty) information of the production and consumption of certain types of chemicals. Relevant production installations are inspected by the OPCW. Just like productions, transfers of certain chemicals are regulated by the CWC, which contains an Annex of Chemicals with three lists of chemicals (known as schedules). Each schedule imposes different levels of restrictions on the production, retention and transfer of the listed chemicals.
- The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was opened for signature in 1968 and entered into force in 1970. As of January 2018, it has 191 states parties. Contrary to the BTWC and CWC, the NPT is not a disarmament treaty. While it delegitimizes the acquisition and possession of nuclear weapons, it does not ban them. It contains no definition of a nuclear weapons. At its heart is a bargain by which non-nuclear weapon states agree not to pursue nuclear armament in exchange for the right to access nuclear technology for peaceful purposes. In addition, nuclear weapon states agreed to eliminate their nuclear arsenals (even though the treaty remains silent about time frames to achieve that objective). The NPT relies on the International Atomic Energy Agency (IAEA), which was founded in 1957, to oversee its implementation. The IAEA promotes the peaceful uses of nuclear technology and power worldwide, and to this end it operates a system of safeguards to prevent their divergence to prohibited purposes. The national reporting under the safeguards system forms the foundation of the verification regime, which includes inspections. Non-nuclear weapon states party to the NPT agree to accept IAEA safeguards. In 1997 an additional protocol provides additional verification tools. The European Atomic Energy Community (EURATOM) operates an independent set of safeguards for its members but acts in coordination with the IAEA.

UN Security Council resolutions

The UN Security Council can impose sanctions on certain countries as a form of non-military action to maintain or restore international peace and security under Chapter VII, Article 41 of the UN Charter. Such sanction regimes are temporary and are lifted when the Security Council assesses that the conditions for their imposition no longer exist. They may target states or non-state actors, such as al Qaeda, the Taliban (Afghanistan) or the Islamic State in Iraq and the Levant (ISIL). In addition, following the terrorist strikes against the United States on 11 September 2001 the UN Security Council has adopted a series of framework resolutions requiring UN members to take relevant measures to prevent the inadvertent transfer of dual-use technologies to state and non-state actors or terrorist use of such weapons. They reiterate the obligations in international weapon control treaties where they are available or impose new sets of obligations and requirements (e.g. reporting). These resolutions are binding on any UN member even if a state is not party to a formal treaty.

- UN Security Council Resolution 1373 (2001) addresses terrorism and the combat against it in more general terms. In paragraph 4 it noted with concern the connection between terrorism and, among other things, the illegal movement of nuclear, chemical, biological and other potentially deadly materials. It emphasized the need 'to enhance coordination of efforts on national, subregional, regional and international levels in order to strengthen a global response to this serious challenge and threat to international security'.
- UN Security Council resolution 1540 (2004) seeks to prevent terrorist and criminal entities as well as individuals from acquiring or transferring biological, chemical or nuclear weapons, including their respective delivery systems. It requires all UN members to adopt and enforce appropriate laws and other effective measures to prevent their proliferation. It calls for enhanced security and safety of and in installations working with the relevant materials. Subsequent resolutions have extended the mandate of the 1540 Committee that oversees implementation of the resolutions and reiterated the resolution's continuing relevance. UN members have also set up an assistance and cooperation program so that all states can meet the requirements.

Informal arrangements

'Informal arrangements' means that a select number of states meet to consult or share intelligence with each other on proliferation threats and risks and adopt recommendations for national implementation of certain measures to enhance coordination among the national policies. Participating states should then review and, if necessary, amend existing legislation, regulations, or procedures. Contrary to formal treaties, membership is by invitation only, which means that a candidate state must already be committed to and have implemented all relevant international treaties and UN Security Council resolutions and demonstrated effective implementation of the national measures.

- The Nuclear Suppliers Group (1974) seeks to control the export of materials and technologies that may contribute to the development and production of nuclear weapons. The initiative was taken by suppliers of nuclear technologies after India detonated a so-called 'peaceful nuclear explosion' in 1974. I sought to reinforce the NPT. Under its guidelines, items on the so-called 'trigger list' can only be exported to non-nuclear weapon states if the recipient state is a party to the NPT or a member of one of the Nuclear Weapon Free Zones, and the transfers can take place under IAEA safeguards.

- The Australia Group (1985) covers the transfer of all technologies—tangible and intangible—that may contribute to the production or other forms of acquiring biological and chemical weapons.
- The Missile Technology Control Regime (1987) seeks to prevent the proliferation of ballistic missiles that can deliver nuclear warheads and other aerial vehicles that can carry nuclear, biological or chemical payloads of above 500 kilograms for over 300 kilometers.
- The Wassenaar Arrangement (1995) seeks greater transparency among participants concerning the transfer of conventional arms and dual-use goods. While it does not specifically address CBRN, among the listed dual-use technologies are many items that could contribute to the development and manufacture delivery systems for CBRN materials.
- The Hague Code of Conduct against ballistic missile proliferation (2002) complements the Missile Technology Control Regime. While it does not ban ballistic missiles, it calls for restraint in their development, production and transfer. Not standing as a separate arrangement, its membership (138) is far larger than that of the MTCR (35).

<u>Regional regulations</u>

The EU Dual-Use Export Control Regime is governed by Regulation (EC) No 428/2009[6]. It forms part of formal law for all EU members and thus comprises common control rules, a common control list and harmonizes implementation. The control list is based on the one included in formal treaties and those adopted by international export control arrangements. It is one of the most comprehensive regulations available and is often presented as a model for other countries to base their own national legislative system on.

4. The dual-use dilemma

In general terms, "dual-use" can be defined as the potential of military application of any technology originally designed for non-military, civilian purposes, and vice versa. However, in reference to CBRN the actual items of technology deemed to be of critical importance for transfer controls are vastly different. Not only are the weapon categories based on different science and technologies, the weapon categories themselves differ in legal status under international law, may have different degrees of definitional precision or regulate precursor technologies.

A major challenge from a regulatory perspective is the determination at what stage of activities a technology ceases to be dual-use and becomes single-use: the weapon has no other purpose than being a weapon. In the nuclear field, for example, many experts would consider that enrichment of uranium beyond 20% is indicative of military intent.

In the chemical area certain compounds, such as mustard agent, sarin or VX, have no other purpose than being a chemical warfare agent. By including these and other compounds in Schedule 1, the CWC states that under international law they have no legitimate application. The same applies to some of their key precursors. No physical or legal entity can claim any justification for synthesizing those chemicals in whatever volume (except for the minute quantities for medical or defensive research in a single small-scale facility, which falls under special verification requirements). Schedule 2 and 3 chemicals pose different degrees of risk to the objectives and purposes of the CWC, but also have broader legitimate

[6] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:134:0001:0269:en:PDF

commercial applications. The CWC foresees in different verification requirements. Each of the three schedules also has different restrictions and reporting requirements with respect to international transfers (bearing in mind that it is as good as impossible to transfer Schedule 1 chemicals). A final consideration is that the CWC obligations are not restricted to scheduled chemicals. The CWC operates under the 'general purpose criterion', which in a nutshell means that any production, transfer or use of any toxic chemical is prohibited unless intended for one of the few listed purposes that are not prohibited. (Prohibition is the default condition, which is why the CWC never refers to 'permitted' purposes.)

Biological agents are the most difficult to characterize from a dual-use perspective. Particular nuclear activities and synthesis of certain chemical compounds will always reach an identifiable stage whereby they serve no other purpose than weapon development. Furthermore, the technologies for defense, protection, and especially prophylaxis and medical treatment differ considerably from those needed for offensive preparations. With infectious agents, the knowledge, equipment, infrastructure and materials required to understand their dispersal, propagation and biochemical mechanisms of infection for detection, prevention and countermeasures are identical to the ones needed for offensive purposes. As the agents are self-replicating, no substantive volumes need to be stockpiled; an industrial surge capacity for production may be all that is required. In other words, the finality of certain activities and preparations may not become fully clear until the agent is loaded into the delivery system. The absence of a verification regime in the BTWC adds to the uncertainties about some types of activity.

In view of the large investments in research and development in the fields of chemistry and biotechnology, the convergence of these fields with other disciplines, and the continuous amelioration of methodologies, processes and products considerable concern exists that these improvements may inadvertently contribute to enhanced chemical or biological agents in the future.

Traditionally, military technology development is subject to different regulation than civil technology development. Often, dedicated weapons research and technology development is classified. Such research tends to be more mature, typically of Technology Readiness Levels (TRLs) 6-9 (from the prototype stage to the actual system proven through successful mission operation). Since 8 June 1977, Article 36 of the First Protocol of the Geneva Convention stipulated that "In the study, development, acquisition or adoption of a new weapon, means or method of warfare, a High Contracting Party is under an obligation to determine whether its employment would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the High Contracting Party." Civil research, including fundamental science and research targeting industrial applications, is subject to different regulations. In those cases, academic freedom and commercial interests are predominant. Some civil research raises dual-use issues of concern. Malsch (2013) argues for assessing the potential consequences of such dual-use research. Any restrictions imposed on this research should always aim for a fair balance between security of citizens and the state and freedom of the academics and entrepreneurs involved in the research.

Prompted by governments of states parties to the BTWC, academies of sciences and other scientific associations have proposed codes of conduct for biosecurity. These include the International Union of Microbiological Societies (2006), KNAW, The Netherlands (2007), the International Association for Synthetic Biology (2009), Italy (2010), Germany and international associations of Biological Resource Centers (both in 2013), and Indonesia (2015). Rowena Rodrigues (2015) reviewed these and other codes of conduct for dual-use research in general. Most codes of conduct for research target biosecurity or unspecified dual-use research in general. This focus on life sciences is probably due to the ubiquitous and highly innovative character of life sciences research with dual-use character, and to its relevance to a wide variety of industrial and societal sectors. These include pharmaceuticals, biotechnology, agriculturally produced food, hospitals, universities etc. Another reason is that bioethics is more elaborated in guidelines and compliance is more actively enforced than ethics in other areas of scientific research. In addition, nuclear industry and research is regulated differently and subject to more strict export control regulations than other sectors (World Nuclear Association, 2015).

Awareness raising initiatives have been undertaken by social scientists interested in ethics of dual-use research. These take the form of online and face to face courses for students, and dedicated sessions at academic events. A leading example is the inclusion of biosafety and biosecurity in training of the teams participating in the international Genetically Engineered Machines (iGEM) competition. Building on this training, the iGEM team Bielefeld in Germany organized a science café discussion synthetic biology issues including biosafety and biosecurity during the GENIALE science festival in 2011.

In addition, several universities offer Massive Open Online Courses (MOOCS), thus bringing university education to the people. A good practice example is the Educational Module Resource, which was offered by the University of Bradford in English, Spanish, French, Russian, Urdu and other languages.

Some funding bodies investing in academic and applied research are also screening the eligible proposals for dual-use issues. Examples are the European Union H2020 research program and the US National Institutes of Health (HHS, 2017). Since 2014, all applicants for H2020-funding are obliged to complete an ethics self-assessment form, and to explain clearly how they intend to address any ethical issues resulting from the proposed research. Contrary to earlier funding practices, projects which are in principle eligible for funding must pass ethics review by at least two external ethics experts. These experts may advise to include additional deliverables or to involve ethics advisors in the project. The list includes dual-use and misuse issues. The EC explains dual-use issues as follows: "Exporting certain goods/technologies can be a security threat, especially in terms of WMD proliferation. Transactions involving such dual-use items can be subject to certain restrictions, which may affect your research project. All H2020-funded projects must comply with the relevant national, international and European Union (EU) laws on dual-use items." (EC dual-use).

The EC explains what they mean with misuse issues: "Some research involves materials, methods or technologies or generates knowledge that could be misused for unethical purposes. Although such research is usually carried out with benign intentions, it has the potential to harm humans, animals or the environment. Although the risk of misuse of research can never be eliminated, it can be minimized by recognizing risks in good time and taking the right precautions. All H2020-funded projects must avoid such misuse and comply with the numerous international, EU and national laws that address concerns relating to potential misuse of materials, technologies and information. If beneficiaries breach any of their obligations under the Grant Agreement, the grant may be reduced or terminated." (EC misuse)

5. ISTC and STCU: leading the work

The ISTC was established in Moscow by international agreement in November 1992 as a nonproliferation program, and later it moved the headquarters to Astana, Kazakhstan. ISTC coordinates the efforts of numerous governments, international organizations, and private sector industries, providing former weapons scientists from the Commonwealth of Independent States (CIS) and Georgia with new opportunities for sustainable, peaceful employment. The current parties to ISTC are the United States, the EU (Sweden was a founding member but then was replaced in 1998 by the EU), Japan, Norway and South Korea, and Canada (who left the Agreement in 2013) as well as Armenia, Georgia, Kazakhstan, the Kyrgyz Republic and Tajikistan.

ISTC activities fall in two broad categories: research projects, which employ FWS in the development of new science and technology (S&T), and Supplemental Programs, which include workshops and other events to integrate FWS in the global S&T and industrial communities; training. In the 20 years ISTC has been active over 70,000 former weapons scientists in more than 760 research institutes spread across CIS and Georgia have been engaged in ISTC projects and activities.

A new ISTC continuation agreement has entered into force on 14 December 2017 putting the organization on a new footing in line with the new security challenges.

The STCU is the first intergovernmental organization in Ukraine and was established by an agreement signed on 15 October 1993, by the four founding parties: Ukraine, Canada, Sweden and the United States of America. The agreement was put into force by Ukrainian President Kravchuk's decree # 202 on 04 May 1994. The STCU, based in Kiev, Ukraine, began its first organizational steps in November 1994, and was fully registered in Ukraine on 14 February 1995. The EU acceded to the STCU Agreement on November 26, 1998, and in so doing, replaced Sweden as a Party to the STCU agreement. Canada withdrew from the STCU Agreement on November 6, 2013. The STCU's main purpose is:

"To support research and development activities for peaceful applications by Ukrainian, Georgian, Uzbekistani, Azerbaijani and Moldovan scientists and engineers, formerly involved with development of WMD and their means of delivery, as part of the general process of conversion to a civilian, market-oriented environment."

As of December 2013, the STCU employed over 3,000 scientists working on approximately 150 projects in the field (approx. 85% in Ukraine, the remainder in Georgia, Azerbaijan, and Moldova). The STCU is made up of one head office located in Kyiv, and four regional offices (1 person each) in Tbilisi, Georgia, Baku, Azerbaijan, and Chisinau, Moldova, and Kharkiv, Ukraine which has two persons located there.

6. Our proposal

In our context of export control, besides government officials, key stakeholders include the relevant industry sectors, scientific communities, academia, students, educators, policymakers and -shapers, the media, and civil society[7]. Education should take the specificities of each constituency into consideration, all the while recognizing that promoting interaction among them will enhance appreciation of the different priorities of each constituency in the pursuit of the shared overarching goal of preventing

[7] Part of this section of the design of educational activities draws on a report prepared by the Advisory Board on Education and Outreach (ABEO) of the Organisation for the Prohibition of Chemical Weapons (OPCW), as summarised in the statement by Dr Jean Pascal Zanders, Chairperson of the OPCW Advisory Board on Education and Outreach, to the 22nd Conference of the States Parties to the Chemical Weapons Convention, The Hague, 30 November 2017. (The report will be published by the OPCW in February 2018.)

undesired technology transfers. Sharing experiences and stimulating potential synergies are but two ways of preventing stovepiping or silo thinking.

With the multitude of constituencies, the optimal educational and outreach processes will vary based on the nature and goals of the event, the composition of the audience, and the societal and cultural contexts. Notwithstanding, there exist certain basic theoretical insights and experiences rooted in practice that can inform any planning, preparation and execution of education and outreach activities. In general, 'active learning' methods that place the student central in the educational process are the best suited to transfer understanding of dual-use problems and the necessity to prevent inadvertent technology transfers, and to get them engaged in policy processes. The approach may be applied in the classroom, the laboratory, or the field. Among the active-learning methodologies are in-class problem solving, case studies, role-playing and other simulations and exercises.

Besides the many different types of stakeholder communities, it is also important to recognize the cultural diversity in education and outreach strategies. There may be important variations from continent to continent, country to country, or even social or professional community to community. Therefore, departing from a portfolio of education activities for each target group of stakeholder communities that allows sufficient flexibility for adaptation to different cultural settings will support the design of specific educational content for a topic like the prevention of inadvertent transfer of dual-use technologies.

When preparing for an educational event, the instructor should answer the following four questions to appreciate the diversity of audiences or even within a single audience (if a mixed group of stakeholder constituencies):

a. Who are they? In other words, what is the scope of the sector, and who are the key actors in it?

b. Why is it important to engage a particular stakeholder? This question requires consideration of the reasons for engaging with a stakeholder.

c. Why would this stakeholder engage with the entity providing the educational experience and technology transfer controls? This translates into the 'how' question. Drawing on the insights of research on education and outreach, how would the meeting convener frame nonproliferation and the challenge of preventing inadvertent technology transfers so as to make the issues relevant and engaging for each of the stakeholders, including key groups within them; and

d. Which messages should be delivered? This question follows from the previous one and the answers will necessarily be highly context dependent. Preparation of an instruction package requires consideration of specific messages for use with each of the stakeholder groups.

Against this background there exist reasons to proceed with multiplying the success of the project in Kazakhstan by way of expanding it horizontally, through its regionalization, and also vertically, through the inclusion of activities to address an additional target group, namely the communities of researchers and scientists

For a variety of reasons, the engagement of members of the academia in the nonproliferation and dual-use export control initiatives is crucially important:

- The involvement of the regional academia in the CBRN risk mitigation will provide greater clarity about the approaches of the research community toward the issues at scrutiny, and will allow to assess the quality of their research and to increase the visibility of their achievements;
- As the technology pace of progress is fast and constantly changes the

environment, the scientific community should be aware of the possible use of their research for CBRN weapons development in order to prevent the misuse of their findings;

- Finally, in view of the specificity of the CBRN field, it is important to have the professionals educated and trained to deal with the challenges, arising from the activities of some the international actors. The target group will comprise of not just natural scientists but, also, lawyers, economists, social scientists, etc. All of these categories of scholars should be prepared to cope with the various dimensions of the prevention of CBRN weapons proliferation.

As noted in the introduction, the interaction among research and professional communities, on the one hand, and the exchange of experiences and best practices, on the other hand, are two mutually reinforcing aims. Hence also the necessity to enlarge the geographic scope of the project, by bringing in, first, the entire group of Central Asian countries - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, (re-enforcing the prospect of the latter two joining ISTC).

Second, the project will cover ISTC members from the Caucasus –Armenia and Georgia– where the scientists experience similar dilemmas to these of their Central Asian colleagues. Additionally, Georgia, being quite advanced in export control regulation, could inject the project with valuable national experience.

Third, the project aims at the inclusion of countries from the neighboring regions of Central Asia, namely: Afghanistan, Pakistan, and Mongolia. Each of these countries has accumulated positive experience from participation in other ISTC-implemented regional projects (P 53, SUNKAR, etc.) and examines the prospects for enhanced partnership relations with the Center. While these participants are important from nonproliferation point of view, the vibrant research community of Pakistan may also provide an outlet to cooperation with other groups of scientists, for example through the Memorandum of Understanding between the ISTC and the Science Foundation of the Economic Cooperation Organization (ECOSF).

Our academic proposal will target different levels in the educational level: undergraduate, graduate, PhD scholarship, other specific professional courses.

The selection of the topics to be addressed under the different format of courses is related to the particularities of the export control as a subject and includes:

- CBRN/WMD history: this module has the objective of share with the participants knowledge about the past use of CBRN weapons to contextualize the importance of export controls.
- Technical aspects of the CBRN/WMD: each weapon has different characteristic, and technology and dual-use materials involved in their development. Since the export controls are applied to the materials and knowledge, this module will directly link the weapons to the export control lists.
- Future challenges of the S&T progress: the technology evolves, and the terrorist organizations and proliferating countries always look for new weapons and new uses of cutting-edge technologies. This module will be useful to raise awareness and to let participants see technology evolution in a new way.
- Introduction to export controls: different instruments are in place and it is critical for the participants to understand the demands and importance of the international regulations.
- Legal concepts: international regulations must be included in a country's legal framework, so here participants will learn about their

responsibilities under such regulatory frameworks and their impact on their work.

- Economy and export controls: among the areas more affected by the implementation of export controls are the economy and international commerce. Here the advantages and possible implications will be addressed.
- International legal frameworks: besides the export controls there are many international agreements that deal with CBRN weapons. Some export control elements included but using different wording. Since all the partner countries are parties of them, they need to understand those obligations too.
- National and regional implementation of export control framework: to have a national implementation the country must have specific capacities in place in several areas, both governmental and private ones. And of course, a regional perspective enables implementers to seek opportunities for regional cooperation and coordination.
- Ethics and Internal compliance programs (ICP): legal tools are part of a top-down approach; ethics and ICP supplement them with a bottom-up engagement by primary constituencies.
- Web of prevention: export controls are a subject that is linked to topics addressed in the other modules addressing issues as Armed Forces; Intelligence; Defense and Response; etc. The combat against CBRN proliferation requires a coordinated and multidimensional approach. The participants will therefore have to integrate all the modules studied to acquire a systems perspective on technology transfer controls.

To encourage the opportunity for individual action, a module on do-it-yourself ethics of dual-use technologies will be included. This can take the form of a lecture with sufficient time for discussion with the audience, but also a workshop or series of practical exercises, teaching relevant principles of applied ethics, and letting the students apply these principles to dual-use dilemmas they are confronted with in their professional practice.

Do-it-yourself ethics is an applied ethics method which is suitable for natural scientists and professionals without academic ethical training (c.f. Malsch, 2012). It aims to assist all stakeholders in implementing a common responsibility for research and innovation, through a combination of technical, legal and social solutions (explained in Malsch, 2018). In a strongly regulated field such as export control of dual-use technologies, the core of ethical behavior is compliance with formal laws (e.g. national laws), soft laws (e.g. international treaties) and voluntary self-regulation (e.g. professional codes of conduct). However, since most dual-use technologies are primarily intended to contribute to health, economic growth and wellbeing, the interpretation of the regulations should be permissive enough to avoid unnecessary restrictions on legitimate academic and commercial activities. In addition to legal solutions, technical solutions including safer-by-design biological and chemical substances can also be explored. For example, many vaccines are crippled versions of pathogenic organisms, which cannot be reverted to the virulent pathogen (even though they are not entirely risk-free, which means that developers and medical personnel too must assess benefits and risk). Toxic chemicals such as some nanoparticles can be coated to improve their biocompatibility and therefore their safety (while at the same time they could be misused as vectors for transmitting chemical or biological materials to cause harm).

Social fixes include dialog about the underlying value-conflicts reflected in legal disputes.

7. Conclusions

The implementation of the Target Initiatives is a challenge we are keen to take and to help with it all the participating countries to contribute with the fight against CBRN weapons proliferation.

Since our fist surveys showed an almost lack of courses on the topics we plan to address, we have identified a gap that could be close with our proposal and activities.

The participants in the 1st Kick-off Seminar in Astana, Kazakhstan (under ISTC), showed great interest, corroborating our assessment and in this way presenting us a fertile ground to work.

We will have our 2nd seminar in May 2018 when we plan not just to present lectures but also to create workshops to involve the target countries in our modules development. This will generate ownership and at the same time enable us to take the cultural variations into account.

The 1st seminar under STCU will take place in March 2018 and we look forward to have the same response that in the one in Astana.

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