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A Verification and Transparency Concept for Technology Transfers under the BTWC

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Introduction

The 1972 Biological and Toxin Weapons Convention (BTWC) is presently the principal tool against biological warfare.[1] As of December 2004, 153 states have ratified or acceded to the convention and another 16 have signed, but not ratified the convention. It encompasses a comprehensive prohibition of preparation for biological warfare. At the heart of the BTWC is Article I, which specifies that states parties cannot acquire or retain biological weapons (BW) under any circumstances. This prohibition is reinforced by the requirement in Article II to destroy or divert all BW to peaceful uses, and by the non-proliferation provision of Article III. By current standards the BTWC is nevertheless a weak treaty because it lacks verification and enforcement mechanisms. There have been some confirmed cases of material breaches and several other allegations of biological warfare and biological weapon (BW) programmes. These have increased the calls to equip the convention with instruments to verify it and enforce compliance. To date efforts to strengthen the BTWC by means of a supplementary legally-binding protocol have failed and the prospects that negotiation of a formal text could resume any time soon are bleak.

Rapid advances in biotechnology and genetic engineering also challenge the future vitality and relevance of the convention. Parties to the BTWC reaffirm the central prohibition in the light of the technological developments during periodic review conferences. However, the failure of the 5th Review Conference in 2001 and at the resumed session in 2002 means that the scope of the norm has not been updated since the 4th Review Conference in 1996.[2] While current biotechnology can be applied to improve the effectiveness of agents or their production processes, the greater concern regards the types of future weapons they may make possible.[3] In this respect, failure of the 6th Review Conference in 2006 would significantly damage the relevance of the convention.

Progress in the fields of biology and biotechnology also fuel the longstanding controversy regarding the right of states parties under Article X of the BTWC to have access to relevant technologies and to participate in information exchanges.[4] The new technologies offer many prospects for the advancement of human welfare.[5] Developing countries in particular do not view them just as a means to improve the health and food security of their societies; they also actively pursue the establishment of a domestic biotechnological research and industrial base with the aim to leapfrog one of more development stages. At the same time, this natural diffusion of technology feeds into the proliferation fears of many advanced countries as they believe that the greater availability of knowledge, skills and materials increases the likelihood of their application in BW programmes. They refer to the non-proliferation obligation in Article III to justify the implementation of technology controls and the development of a range of technology denial and interdiction strategies as part of their counter-proliferation policies.[6] The different types of security concerns—societal versus military—create diverging expectations from the BTWC.

The controversy is exacerbated by the convention's inability to verify compliance with its prohibitions. This applies particularly to the recipient's utilization of the transferred goods. Biotechnology transfers in particular are difficult to monitor. On the one hand, some of the substances—microbial agents or their parts—can be transferred in such small quantities that they go undetected or unmonitored. On the other hand, relevant technologies are often intangible as they include data, processes and expertise. In addition, much of the equipment and the processes used for the study and production of microbial agents have dual-use characteristics: while they hold out many promises to improve the quality of life, they can also easily be applied for hostile purposes, for instance, to improve the stability and virulence of existing warfare agents or to create new agents based only on some components of an organism. In contrast to other weapons, the final phase during which such technologies with dual-use potential are unequivocally being applied for BW purposes is virtually non-existent. As a consequence, awareness that a transaction is actually taking place and ascertaining that the transferred technologies are not diverted for purposes prohibited under the BTWC become extremely complex security issues.

An important part of a future verification process will consequently have to focus on keeping technology transfers as transparent as possible (and thereby contribute to the building of confidence). In addition, it is becoming increasingly clear that the security concept can no longer be limited to 'military security' alone. It involves several layers such as personal security, economic security (for companies, states, etc.), societal security (including health issues, food and water security), political security (regime survival), environmental security, and so on. The AIDS disaster in some African countries illustrates how these different levels are intertwined. A future technology transfer regime in support of the prevention of the weaponization of disease will have to be designed in such a way that it does not give rise to ethical concerns regarding human welfare.

This paper first discusses the armament dynamic in order to provide insight into how political entities—states as well as non-state actors, such as terrorist or criminal organizations—may structure the programme to acquire BW. The assimilation model identifies, on the one hand, a set of enabling factors that have a major, and in some cases critical, influence on how the BW programme will be set up, and, on the other hand, a set of contextual factors that determine whether the political motivation exists to start up or pursue the programme. In the event such a programme is set up, there remain many hurdles to be crossed before the weapon is assimilated into the mainstream military doctrine.

The assimilation model studies the demand side of the weapon acquisition process. Analysis of the material base in particular reveals ingredients that may be missing to support the armament dynamic and thus create the import dependency of a political entity.

In this way it becomes possible to study the processes of technology transfers (the most visible aspect of the so-called proliferation process) from the demand side. The paper looks at these dynamics in both states and non-state actors. The analyses reveal the complexities of BW programmes and point to the different levels on which the proposed technology transfer concept for may be relevant for early detection or prevention of a BW programme.

In the light of the specific challenges the nature of biology and biotechnology pose to the monitoring and verification of activities in support of the norms against the prevention of the weaponization of disease the paper next discusses the concept of ‘dual-use technology’. However, the understanding of the concept must be taken beyond the traditional civilian–military paradigm as the BTWC, by virtue of the general purpose criterion (GPC), distinguishes between permitted and prohibited purposes. Operationalizing the GPC is key to making the proposed transfer model applicable to the technology flows allowed under the convention.

Finally, the paper proceeds to outline a technology transfer concept that aims to maximize transparency. Based on the understanding of the demand side of a potential BW programme, it builds on the interaction of different types of economic units. This interaction, in combination with the supervisory roles of national authorities and an overarching international body, which is also responsible for setting common standards for the technology transfers, will enable the generation of transparency regarding the application of the technology after the transfer. The paper briefly considers different ways how the concept might be realized before offering some general conclusions and identifying some areas for further study.

Supply and demand side in technology transfer controls

In a broad sense, proliferation is the lateral spread of certain types of weaponry from a place where they are present to another place where they have yet to be introduced. However, the concept is fluid as few analysts deem it necessary to define it. The term is sometimes synonymous with armament dynamic (in some instances also labelled ‘vertical proliferation’, in contradistinction to ‘horizontal proliferation’). It also evokes negative connotations, which is not always present in other terms like arms trade, weapon transfers military assistance, and so on. This semantic differentiation is closely linked to the type of weaponry under discussion. In other cases the term suggests a continuous technology flow that must end in advanced weaponry and eventually its use in war. This line of reasoning, with its implicit automatism and inevitability, runs into difficulties with respect to the natural diffusion of technology. Ultimately development, scientific and technological progress and industrialization become proliferation concerns in their own right. It is therefore necessary to frame the concept of proliferation and identify its specific characteristics with regard to biological weapons.

The proliferation process can take on different forms. In some cases entire weapon systems are transferred; in other cases the recipient acquires technologies—knowledge and expertise, equipment, or other commodities—to set up a domestic armament programme. However, the ways in which a particular type of weaponry has been problematized and the proliferation issue has been framed inform threat perceptions and policy preferences for dealing with those threat perceptions.

The question of the accumulation of weaponry by states—whether through domestic development and production or through acquisition from foreign sources—has preoccupied policy makers for decades if not centuries. The parameters for those security debates changed over time. For instance, after World War 1 many policy makers from the victorious Allied nations were convinced that not possession of chemical weapons (CW) as such was destabilizing. Instead they viewed that an imbalance between the chemical arsenals of any two countries might contribute to rather than prevent the outbreak of war. Based on this belief, some of the larger European powers assisted some of the smaller ones in acquiring a limited CW capability.[7] The weapon as such was not viewed as problematic; only its use in war was. Hence, in 1925 the international community was unable to ban chemical and biological weapons (CBW). Instead it extended the laws of war to cover the use of CBW on the battlefield through the 1925 Geneva Protocol,[8] although the very nature of the agreement—a contract among states—allowed for retaliation with CBW in the case a party violated the protocol. Several states explicated this understanding in formal reservations.

After World War 2, which was brought to a close by the use of the atomic bomb in August 1945, the perception of the contribution of technology to international security shifted significantly (but this shift was by no means universal). One of the first resolutions adopted by an organ of the United Nations recognized the destructiveness of the new class of weapons.[9] In addition, the technology was increasingly being perceived as problematic over the next decades. On the one hand, the levels of destruction that nuclear weapons might cause were intolerable from the perspective of the continuation of civilization and even of life on Earth. On the other hand, the technology was seen as unsafe. The development and testing of the weapons was poisoning the environment on a large scale even without their use in war. The weapon systems were also becoming so complex that the risks of a mishap with the warhead or an accidental launch increased substantially. Lastly, the core role nuclear weapons played in the cold war military doctrines of the United States and the Soviet Union required split-second decision making mechanisms that were more and more delegated to machines, which in turn increased the risks of mishaps. The slightest mistake in the management of technology or technical failure could produce a catastrophe similar to the use of the nuclear weapon in anger. The projected consequences are so unpalatable that even the introduction of mechanisms and procedures to prevent accidents or unintended launches was unable to alleviate the concerns about the technology itself.

If compared to the historical perceptions of CBW, five factors helped to shape the debate on the spread of nuclear weapons, namely,

- only very few states possessed the means to develop and produce nuclear weapon systems, and they placed these weapons in the core of their security posture;
- the acquisition of nuclear weapons by more states was seen as highly destabilizing;
- denial of access to technologies critical to nuclear weapon development was seen as the policy instrument to preserve stability and reduce the risk of accidents;
- the use of nuclear weapons in war is not explicitly prohibited under international law; and
- as nuclear energy was also valued for its positive contribution to economic and societal development, its peaceful uses should be promoted. (In contrast, discoveries in chemistry and biology and their industrial application preceded the use of toxicants and pathogens in war by several decades.)

The combination of these factors shaped the basic approach to the prevention of nuclear weapon proliferation: supply-side controls on critical technologies would prevent new countries from acquiring nuclear weapons, while a transparency-enhancing verification system would safeguard the right to the peaceful uses of nuclear energy. Contrary to the principles with respect to chemical weapons applied before World War 2, the approach in essence determined that proliferation endangered international peace and security. Meanwhile, the nuclear weapon as such and its potential use in war was not delegitimized.[10] The *de facto* creation of two distinct categories of states—nuclear weapon possessors and non-possessors—became a key characteristic of the 1968 Nuclear Non-proliferation Treaty.

The route taken to control chemical and biological weapons is fundamentally different: they were delegitimized and removed from the military arsenals, resulting in disarmament rather than non-proliferation. One, if not the key reason for the different approaches is the Geneva Protocol. Despite its intrinsic weaknesses and the several serious violations in letter and spirit, the document fundamentally challenges the legitimacy of the use of poisonous and disease-causing agents on the battlefield. As a direct consequence, promoters of chemical and biological armament always had to go to extraordinary lengths to justify the weapon programmes against strong moral and political opposition. Few governments openly admitted to chemical and biological weapon stockpiles or programmes, and therefore could never acquire domestic or international prestige from their possession.[11] Combined with the many technical difficulties in their production and storage and the logistical burdens for the troops employing such weapons or operating in contaminated areas, legal and moral barriers prevented CBW from occupying a core role in the military doctrines of countries. After World War 2 the atomic bomb and the emergence of advanced conventional weaponry that could perform the doctrinal tasks of CBW without many of their moral or logistical disadvantages further contributed to their status as peripheral categories of weaponry. Their elimination would therefore not greatly affect national security policies.

Already in the early 1930s the Conference for the Reduction and Limitation of Armaments, which was convened under the auspices of the League of Nations, considered a proposal to comprehensively ban chemical and biological weapons, which also included a prohibition on preparations for chemical and biological warfare in both peace and wartime and on the training of troops in the use of such weapons.[12] The negotiations failed as a consequence of the fast deterioration of the political climate in Europe. The disarmament approach was resuscitated in the late 1960s and resulted in the BTWC and the 1993 Chemical Weapons Convention (CWC).

The demand side in biological armament

The debate shift from CBW armament/disarmament to proliferation/non-proliferation in the late 1980s and 1990s discredited armament theory. Existing models of the armament dynamic were already suffering from serious deficiencies, not in the least because they were low in predictive power and often only applicable to the weapon system under consideration. Their application to chemical and biological armament was particularly problematic because the analyses were invariably based on 'successful' weapon systems that had pushed the frontiers of the scientific and industrial capabilities of countries.[13] The cold war context with its focus on the two superpowers also contributed to the weakness of armament theory, because material constraints were hardly, if at all taken into account. Advanced weapon programmes in particular appeared able to draw virtually without any limitations on scarce resources. For second-tier and lesser powers, the country's physical base as well as economic, industrial, technological, scientific, educational, cultural and other limitations may push a particular weapon system or arms category beyond domestic development. These restrictions exert a decisive influence on how these powers structure their armament dynamic. (In fact, the economic collapse of the former Soviet Union and the debt burden incurred by the United States in the 1980s indicate that both superpowers could temporarily ignore, but were not immune from the constraints in their material base.) Technology importation is indeed one way of overcoming those domestic deficiencies. The understanding of these domestic factors in the armament dynamic is central to the conceptualization of a technology transfer monitoring model, because it explains the motivations and the circumstances under which a state will seek to import specific technologies. As will be discussed in more detail later, similar principles apply to the acquisition of BW by non-state entities. Most importantly, the understanding of the demand side of an armament dynamic will demonstrate that the acquisition of BW is neither easy, automatic nor inevitable.

Key to the understanding of the demand side is the concept of assimilation:[14]

> Assimilation is the process by which for a particular weapon, weapon system, or arms category political and military imperatives, as constrained by the political entity's material base, become reconciled with each other so that the weapon, weapon system, or arms category under consideration becomes an integral part of current mainstream military doctrine.

Any weapon, weapon system or arms category must consequently satisfy political as well as military imperatives. This presupposes the existence of a dual decision-making track, one on which military appraisements are primordial and one on which political considerations play the dominant role (see figure 1). The military track relates to those decisions taken by the military establishment to effect the military facet of the security policy of a political entity, including first and foremost the development and implementation of doctrine. The strategic planners will take into account external factors, such as the changing military threat, and internal factors, such as outputs of decisions on the political track. On

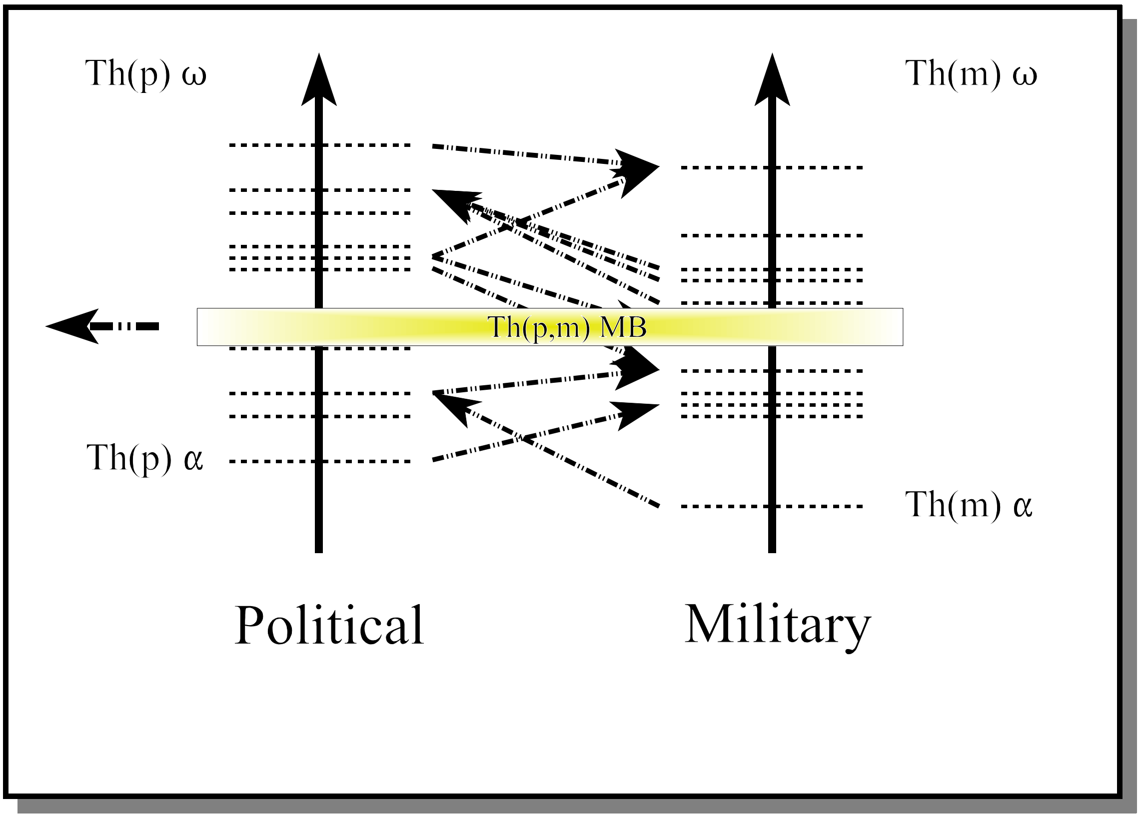

Figure 1

the political track, overall policy decisions regarding security and the furnishing of means for implementing that security policy are taken. These may range from the formulation of a national security policy by the government and the parliamentary budget process to the expression of institutional interests inside and outside the armed forces and inter- and intra-service rivalries within the military. As the military and political tracks interact with each other, any decision or set of decisions not only influences future decisions on the same track but also has ramifications for progress on the other track. A considerable level of tension may exist between both tracks, especially if operators on one track make demands which are irreconcilable with the basic goals or premises of the actors on the other track.

The initial proposal for a particular type of weaponry envisages a particular end result. However, the weapon actually produced and deployed with the armed forces may differ significantly from the originally anticipated platform. The process involves many discrete minor and major decisions at the various stages of the armament dynamic. As the proposed weapon system enters the decision process, multiple thresholds (Th) must be crossed. Thresholds occur both on the political (Th(p)) and the military tracks (Th(m)).They may relate to a variety of issues, such as overcoming environmental concerns, finding fiscal resources, convincing the military of the programme's utility, political opportunism, priority allocation of resources to overcome technical difficulties, pressures for disarmament or from international humanitarian law, public opinion, difficulties in changing existing military doctrine, and so on. To overcome such an obstacle an opportunity cost has to be paid. Opportunity cost not only involves monetary or other resource costs to overcome the obstacle, but also the expenditure of political capital to ensure continuation of the programme at a particular stage.[15] Different times and circumstances may thus result in different opportunity costs to be paid for similar decisions at a comparable stage of the armament dynamic.[16] Decisions against the armament dynamic are as crucial as those promoting its continuation: they will affect the outcome as a consequence of an increased variance between the original concept and the final product. At the end of the armament process the summation of all opportunity costs paid at each threshold will determine the final outcome of the weapon system. If the aggregate opportunity cost is too high, then the armament dynamic has failed.[17] This ability to account for failure is the principal reason why the assimilation model rejects the automatism in the weapons acquisition process.

The nature of the thresholds is determined by intrinsic factors if they refer to the country's material base and contextual ones if they relate to the environment in which the weapon system is being conceived (e.g., external threats). The country's material base constitutes a particularly important independent variable (Th(p,m) MB) affecting decision-making on both the military and political tracks. It includes factors which can hardly or not at all be influenced by the decision processes within the time frame of the armament dynamic under consideration. It consists of a country's physical base—geographical position, territorial size, population size, presence of natural resources, easy access to resources abroad—as well as the stand of the population's education, the level of scientific, technological and industrial development, economic strength, culture, and so on. In other words, all other factors being equal, differences between the material base of any two countries may account for the different characteristics and results of the respective outputs. Each of the intrinsic and extrinsic elements may raise or lower the opportunity cost for crossing the hurdle.

Assimilation and its implications

Assimilation is a dynamic process whose finality is the reconciliation of the political and military imperatives within the armament dynamic so that the proposed weapon system can achieve a high degree of integration in the current mainstream military doctrine.[18]

Operational deployment of that weapon system is the most visible indicator of such reconciliation. This 'operational deployment' goes beyond mere 'deployment', which might be understood as the production and subsequent storage of a particular item at some remote military depot with little integration into the military doctrine.[19] Evidence of operational deployment are troop training exercises in the use of the weaponry according to tactical and strategic guidance at the different levels of military organization and desktop exercises with scenarios involving the use of such weapons.

Having achieved such a stage of operational deployment does not imply that the weapon system cannot be further developed. The assimilation process continues to operate as the weapon system must remain integrated in the military doctrine. Despite its underlying resistance to change, military doctrine is also an evolving variable. In addition, the weapon system also has to face up to changes in the hostile threat it was designed to counter and to challenges from new or alternative weapon systems intended to meet similar military requirements. Developmental stagnation implies the diminution of the weapon's position relative to the overall security posture. Obsolescence for internal (e.g. no longer adapted to meet doctrinal requirements) or external reasons (e.g. the fielding of a new weapon system by an adversary) may also be a major cause for dwindling integration. Processes known as the 'follow-on imperative' and 'suboptimization' operate to keep particular types of weaponry operational while avoiding too great resistance to the continuation of the armament dynamic. Other processes such as 'function specialization' or 'function shift' preserve the continuation of a weapon system, although its doctrinal role may be more limited or radically different from the originally envisaged one.

The relationship between 'operational deployment' and 'use' is far from straightforward. Deployed weapon systems may not be used in an armed conflict, such as strategic nuclear missiles. On the other hand, weapons may be employed without having been deployed. The bombing of Hiroshima and Nagasaki occurred without a guiding nuclear doctrine nor did the operations follow the established principles of strategic bombing. Some operationally deployed weapons may fail to meet up to expectations after their use on the battlefield and be rapidly withdrawn, like the JP233 runway denial weapon initially used by the Royal Air Force in its attacks against Iraqi airfields in 1991. In contrast, assimilation is not a prerequisite for use as evidenced by the first German chemical attack in April 1915 or the first Iraqi chemical attacks of 1982. However, it appears inconceivable that experimentation with a new piece of weaponry or mode of warfare on the battlefront proceeded without having gone through some authorisation process. Reasons exist to argue that a ‘variation’ of assimilation occurs in terms of a shortened process between initial conception and battlefield employment, during which many influencing actors are excluded or play a diminished role (cf. politicians, extra-parliamentary opposition) while others (cf. the military, scientists) have a greater impact due to the abnormal circumstances. The political and military imperatives still become reconciled with each other. Final selection and integration of the novel weaponry or mode of warfare in mainstream military doctrine, however, occurs on the battlefield. Bizarre proposals, which otherwise would have been rejected out of hand, sometimes make it to the battlefield as a consequence of influence peddling or in the belief that anything that might aid the war effort must be tried. Most are eliminated on the way to integration in mainstream military doctrine. Chemical warfare, as well as many other innovations, followed such a pattern during World War 1. However, the historical record strongly suggests that in the case of such a ‘compressed variation’ of the assimilation process the impact of the weapon will fall well below original expectations or the theoretical potential of that weapon.

Finally, the stage at which a weapon system is to be considered as operationally deployed depends on the criteria for deployment maintained by the political entity. This implies that deployment is not a function of technological development. If, for instance, a less developed country obtains highly sophisticated and fully developed weaponry but does not have the resources nor the skills to maintain or fully utilise that weaponry, deployment may be short-lived (e.g. rusting in a hanger, or too highly valued for use in an armed conflict) and actually lead to reduced military effectiveness. On the other hand, a not fully developed system may be deployed under pressure of circumstances, whether political or military. The US deployment of a missile interceptor system in Alaska in 2004 is a case in point.[20]

The demand side perspective of the proliferation process

The identification of a country’s material base as an important independent variable affecting decision-making on both the military and political tracks is key to understanding the demand side of the proliferation process. Following the initial political decision to acquire a particular type of weaponry a political entity may encounter an important threshold in its material base that cannot be solved by a decision to commit particular resources on either the political or the military track. This threshold cuts through both decision making tracks (Th(p,m) MB in figure 1).

Elements, alone or combined, that may play a role in defining the threshold are the political entity's scarcity of certain natural resources, lack of technical skills, insufficiently advanced education, an insufficient research and development or industrial base, etc. Barring abandonment of the entire project, the political leadership has two basic options: either it will try to develop the missing ingredients indigenously or it will decide to seek them abroad. It may, of course, also opt for a combination of both. However, given the probable time frame within which the armament programme must be realised, importing the missing elements may be the only feasible and, in the short run, the cheapest option available. Especially if the dearth occurs in the physical base of the political entity importation may be the sole possibility. In other words, the decision and the subsequent actions to seek certain ingredients abroad, whether legally or illegally, is but one way of structuring the political entity's armament dynamic.

This demand side perspective on BW (or any other type of weaponry) proliferation offers the following definition of the process:

> Biological weapon proliferation occurs when a political entity decides to acquire a biological capability where such a capability does not yet exist provided this decision is followed by a BW armament dynamic.

As the assimilation model allows for failure of the armament dynamic, it thus also becomes possible to define the reversal of the proliferation process:

> Biological weapon deproliferation occurs as soon as the political commitment to that decision ceases to be renewed or if that political entity explicitly reverses that decision.

The hurdle to be crossed at Th(p,m) MB is for a technologically less advanced country seeking a biological warfare capability a particularly high one. According to the assimilation model there will be important opportunity costs to overcome it. The size of these costs depends primarily on the extent of the preconditions for biological armament that are already present within the political entity.[21] The political authorities, for instance, will have to consider the financial implications of a biological warfare project and the required long-term investments (e.g., training of scientists and technicians abroad). In addition, it is far from certain that embarking on BW programme will enhance the nation's security. Indeed, it may face important international repercussions if the importation affects the external security of other countries or the dealings, after having become public, are undeniably illegal or contrary to international norms. Furthermore, the political entity makes itself dependent on foreign suppliers, and sources might be shut off. The revelation of an offensive BW programme may thus leave a country in a worse security condition than before it started the armament dynamic, and, unlike the current tendency with regard to covert nuclear weapon programmes, achievement of the weapon capability does not confer a higher power status.

The understanding of the impact of the different components of the material base on the armament dynamic will also explain why the lesser or least developed countries are unlikely to develop a domestic BW programme. Their societies and economies are entirely unable to sustain the effort. Virtually every single step in the armament process, ranging from design, construction, operation and maintenance of facilities to the hiring of qualified personnel and training of the military, would have to be imported, making the countries highly vulnerable to foreign interests. Despite the popular qualification of BW being the poor man’s atomic bomb, their proliferation is not an issue involving the lesser or least developed countries.

The armament dynamic: overview of the process and its implications

The study of the armament dynamic according to the assimilation model is summarized in figure 2. Each block consists of sets of related thresholds. The material base (bottom left) comprises a range of enabling factors. They determine the preconditions whether a state will be able to set up or sustain the armament dynamic and the degree of import dependency should that state wish to proceed with the programme. The thresholds located in the physical base are virtually impossible to modify through policy development. The other ones can be changed, but it may take many years, if not decades of sustained policies for the effects to become tangible.

The blocks in the centre left group contextual factors that will help to determine whether the political commitment to the armament dynamic will be sustained. A major field of tension exists between threat perceptions, on the one hand, and the adherence to international norms and laws, on the other hand. In this field of tension policy preferences with regard to societal development and national security are formulated and implemented. National security policies inform the development of military doctrine and the nature of the weapons the military forces require to meet the doctrinal demands. The surface of the ‘threat perception’ block is larger than the one for ‘international norms’ to symbolize that state survival may take precedence over normative behaviour. The perception of existential threats may, among other things, result in the refusal to sign up to international arms control and disarmament treaties, the pursuit of weapon capabilities that would otherwise be difficult to justify,[22] or the militarization of civil society.

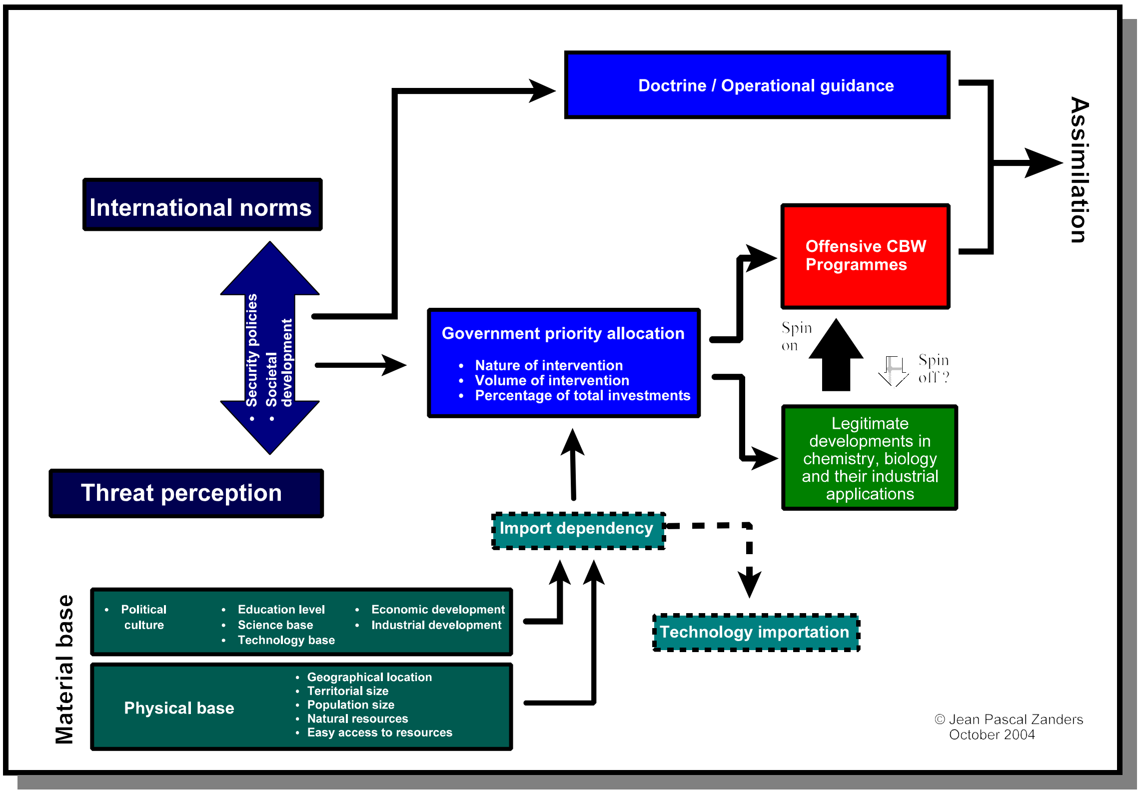

Figure 2

The enabling and the contextual factors determine the government priority allocation. Resources may thus be invested in legitimate projects in the fields of biology and biotechnology or in support of (illegitimate) offensive BW programmes. At this stage the nature of governance plays its greatest role in the structuring of the armament dynamic. Earlier it was noted that the historical record offers no support for the assertion that only certain types of governance (e.g., so-called 'rogue states') will pursue biological or chemical weaponry. Indeed, some of the largest BW programmes were maintained by democracies. The need to acquire BW may emerge from the field of tension between threat perceptions and international norms. While the sources of insecurity may differ according to the type of political organization, the key point is that if the leadership decides to fulfil that need, then it will structure the armament dynamic in such a way that the chances of its successful conclusion are maximized. In a democracy the leadership must deal with public opinion and it will develop an appropriate discourse (ranging from the invocation of external existential threats to the imposition of secrecy) to overcome parliamentary or extra-parliamentary opposition or, at a minimum to convince key constituencies (e.g., scientists, the military, etc.) of the overriding need for such weapons. A dictatorship, in contrast, will be less concerned about public opinion. Key constituencies may feel compelled to participate in the armament programme for fear of their personal security or willingly contribute because of ideological affinity with the political leadership, career opportunities or generous funding offered for other types of (legitimate) research. It may also have to invest more resources in overcoming, for example, scientific and technological deficiencies in the material base.[23]

Few countries are presently believed to have full-scale offensive biological warfare programmes, although some concern exists that some states maintain capabilities to start up agent production at short notice or embed offensive research and development in otherwise legitimate BW defence projects. In contrast, biology and biotechnology progress at an ever-increasing pace. In some cases, research and development are generously supported by public funds. Despite the clear non-military dynamic, many of the resulting insights, technologies and processes could contribute significantly to future BW programmes. There are two main ways in which this could happen. First, technologies developed for civilian use are instantly applied for the purpose of acquiring BW (spin-on effect). A massive technology transfer from civilian to military use might happen in the case of a major crisis: the switch to the production of military agents in industrial installations may only be a matter of days.[24] While technically feasible, reality may actually be less dramatic as no assimilation process would have taken place and the troops would consequently not have been prepared for offensive biological warfare. The second way is much more gradual. Biotechnology produces enabling technologies for many civilian applications that contribute to future information accumulation and product and process improvements. These developments gradually transform the material base by improving the educational, scientific and technological foundations of the society in which they take place. In other words, they enable a society to embark on an advanced BW programme. Combined with a growing belief that the new and future technologies could turn pathogens into controllable weapons while reducing the risks to one's own troops and civilian population, they could begin to lower the opportunity costs for a weapon programme. This gradual development is also more likely to be accompanied by investigations how the new biological weapons could be incorporated into the military doctrine, thus setting the stage for the dual-decision making process.

As figure 2 indicates, military doctrine is informed by the threats to which a state is exposed and the international norms to which that state adheres. One of the direct effects of disarmament treaties is that they remove the necessity for operational guidance for the banned weapon. Lack of operational training on the different levels of military organization quickly make that weapon a useless object in the military arsenals. The removal of a weapon category from military doctrine is together with the physical elimination of existing weapon stockpiles a crucial impediment to future rearmament. However, the effectiveness of disarmament treaties in this respect is directly related to the scope and the clarity of the prohibition. The threat to the BTWC and the CWC from so-called non-lethal agents (including riot control agents) follows not so much from the intrinsic properties of biochemical agents as from the fact that military units retain operational knowledge of their use in combat. As the current debate about the so-called incapacitating chemical and biological agents in the USA testifies, a rational in support of their assimilation with the military can be developed (e.g., combat in urban areas where civilians and fighters are mixed, media presence, and so on) and pressure is already emerging to reframe the conventions in order to exclude the so-called incapacitating biochemical agents from the definition of a biological or chemical weapon.[25] The maintenance of such knowledge and expertise considerably reduces the height of certain thresholds in the armament dynamic. It also shapes the circumstances under which the massive transfer of biotechnology from civilian to military use would be less problematic in the mobilization for biological warfare. As history testifies, the resort to lethal agents has almost invariably been preceded by the use of irritants or incapacitants.

Application of the assimilation model to non-state entities

Terrorism with pathogens became a primary concern in the 1990s, after it was learned that the Japanese religious cult Aum Shinrikyo—responsible for two deadly attacks with the nerve agent sarin in 1994 and 1995—had also pursued but unsuccessfully released biological agents. Although another religious cult, the Rajneesh, had infected some 750 people with salmonella in an attempt to influence local elections in Oregon, USA, in 1984, the threat became a matter of utmost urgency in 2001 when an unknown perpetrator killed 5 people and infected 17 more with anthrax spores delivered in letters. The fact that the anthrax attacks occurred in the wake of the terrorist strikes against the USA on 11 September 2001 heightened threat awareness across the world. The events have sparked a rash of analyses of catastrophic terrorism with biological and chemical agents. The scenarios tend to focus on the limits of what is technically feasible and detail all possible vulnerabilities in democratic and industrialized societies.

The assimilation model can also be applied to the proliferation of chemical or biological weapons to sub-state actors, although operational analysis is necessarily limited by the paucity of empirical data. The comparative analysis of Aum Shinrikyo and the Rajneesh cult reveals information about the influence of the organizational structure on the armament dynamic and the goal-instrument link. The comparison of Aum Shinrikyo's CBW programmes with those in some countries like Iraq and Libya highlights significant thresholds in the material based and the impact of the import dependency on the armament dynamic in a terrorist organization. This approach is possible because, as noted earlier with regard to proliferation studies, the identity of the thresholds can be assumed to be equal for all political entities. However, the relative height of the thresholds will vary among them. Certain thresholds identified for states will consequently only play a minimal or no role in

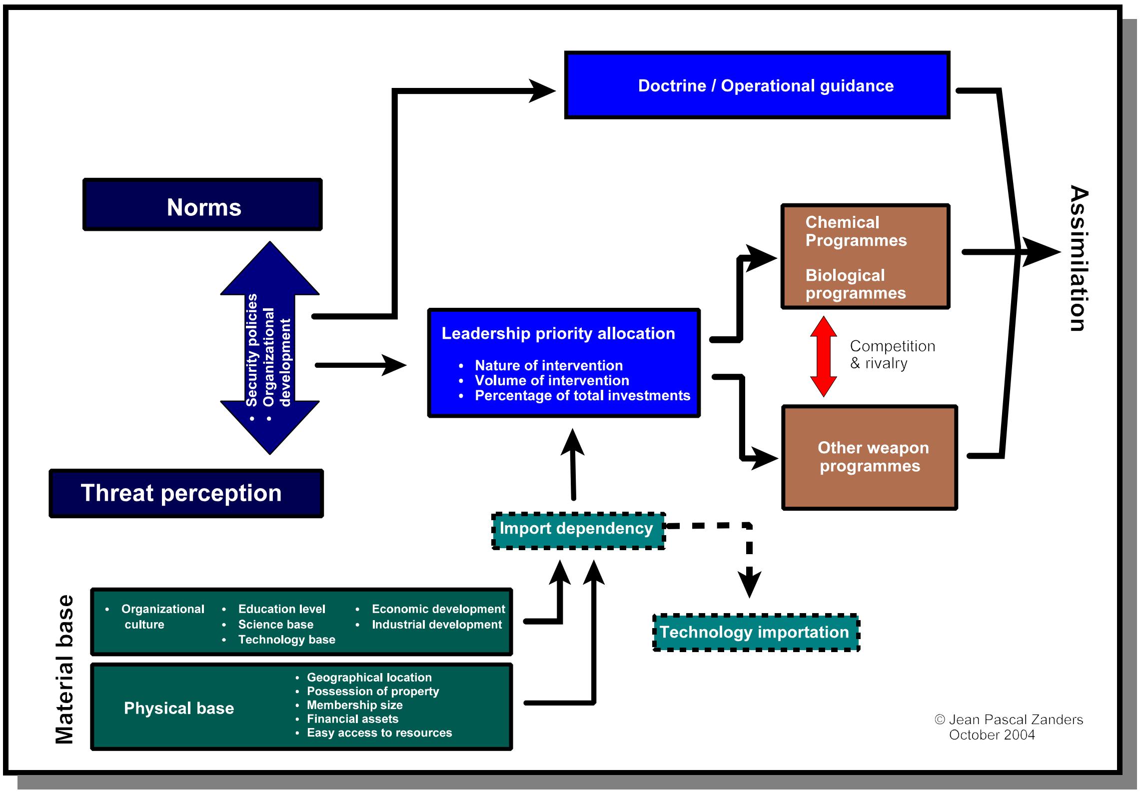

Figure 3

a terrorist organization, while other ones will have a far greater relative impact. Finally, the basic analytical model developed for the study of armament dynamics in states about which limited information on decision making processes is available can be applied with some modifications (figure 3). Using the so-called 'black box approach', variations in parameters like organizational structure and ambitions reveal possible outcomes, which, while remaining a cause for serious concern, are far removed from those in catastrophic scenarios.[26] The key findings are:

- *goal—instrument relationship*: BW make little sense unless they are applied to obtain specific goals.[27] These goals help to determine the selection of the agents and the ways in which they will be applied (e.g., assassination, temporary incapacitation, indiscriminate killing, and so on). The higher the terrorist organization places its ambitions, the more likely it will consider biological agents as one among many instruments. In its efforts to secure a majority in local elections in November 1984, the Rajneesh cult attracted homeless people to its village, Rajneeshpuram, and registered them as voters. It also considered the dissemination of *Salmonella typhimurium*, a common cause of food poisoning, in order to prevent local people from voting. A trial run in September made over 750 people ill. The next month, however, the cult realized that its attempt to take over the county would fail and it did not undertake any additional attacks.[28] It is noteworthy that the leadership consciously selected an incapacitating agent over a lethal one and that it did not pursue the biological attacks once the primary goals appeared unattainable. To Aum Shinrikyo BW represented one of the possible avenues to the ultimate goal of destabilizing Japan and taking over the government.[29] They were to be used in conjunction with other exotic or devastating weapons, as well as with ordinary conventional firearms. (Arguments such as ease of production or relative cheapness merely have a bearing on how certain thresholds are overcome in the pursuit of these goals. In the case of Aum Shinrikyo these factors were arguably of limited importance in view of the massive investments in the other weapon programmes. They may have played a role in the sequence in which the various armament programmes were launched.) Had the sect focussed exclusively on BW, it would have probably solved the problems of viability of the chosen pathogens, large-scale production and effective dissemination. However, such an exclusive focus would not have served the totality of the final goals.

- *material base*: The material base is a key determinant. A terrorist organization does not occupy a territory like a state, so it must basically 'import' all its technologies. Nevertheless, the society in which it is embedded may have a significant influence over opportunities and choices. Depending on its ambitions, the terrorist organization will in its initial phases undertake a range of activities to expand and support its material base. Protection of religious freedom and tax exemptions, for example, facilitate recruitment and the establishment of commercial activities. A country with advanced scientific, technological and industrial foundations will not only influence the thinking inside the terrorist organization, but also offers a recruitment pool of people with the required skills to set up complex weapon projects. A second group of enabling factors in the material base consists of the internal organizational characteristics, which the terrorist group can exploit, manipulate or develop in function of its goals. Aum Shinrikyo, for instance, set up a complex of chemical factories and biological laboratories during a period of almost five years.[30] These efforts underscore the need to sufficiently develop the science and technology base as well as the level of education and training within the organization. The cult launched repeated recruitment drives to attract promising young scientists and people with other required skills from Japan's leading institutes. These people were able to set up the programmes and build the necessary installations. However, the detailed study of the cult's material base revealed a significant flaw that may have been a determining factor in the failure of Aum Shinrikyo's biological programmes: the skills were not evenly distributed throughout the organization. The cult relied on relatively un-skilled sect members for the operation and maintenance of the installations. In order to preserve internal secrecy they were primarily selected for their proven dedication to the cause of Aum Shinrikyo. Many mishaps, including inadvertent contamination of pathogen cultures and leaks from installations, were the direct consequence. While such mishaps may still lead to impure toxic agents, mistakes with cultures produce non-viable biological agents. Similarly, the limited functional specialization of the staff contributed to the failures. The people in charge of developing the agents were also responsible for developing the infrastructure for agent production and the dissemination devices. Despite their lack of experience in operational planning, they also prepared and executed the attacks. In contrast, the Rajneesh's BW project was much more limited in scope and time. The cult was responding to a rapidly evolving crisis that threatened its continued existence and did not have the time to set up a material base to develop weaponry. The person in charge of the biological programme was a qualified nurse with sufficient skills to cultivate a pathogen, but not to set up a sophisticated enterprise. In order to influence the outcome of local elections, the cult could opt for an incapacitating rather than a lethal agent, thereby narrowing the technical requirements for the laboratory. The choice for a a liquid solution with *Salmonella* strain to be poured on the food in public places simplified the technological requirements for dissemination and reduced the need for far-reaching functional specialization.

- *the military track*: The part of the dual decision-making track on which a political entity formulates its military doctrine may be argued to be non-existent for terrorist organizations. Nevertheless, the goal-instrument relationship suggests that such a group can be expected to have an idea, however vague, about why it is seeking biological agents. According to the assimilation model, incomplete or imprecise formulation of these goals increases the likelihood of the wrong choice of agents, inadequate dissemination devices and procedures, or outcomes far below theoretical expectations (although an aleatory combination of factors can never be excluded).
- *moral economy and threat perceptions*: A terrorist group arises as a consequence of the fundamental dissatisfaction of its members with certain (or all) aspects of societal organization. Inevitably, that society will pose a threat to the very existence of the terrorist group. The greater the existential threat to the organization, the greater the chance of its resorting to extreme measures. In fact, this is the shared feature between the Rajneesh[31] and Aum Shinrikyo: they both turned to the indiscriminate use of non-conventional means when public authorities threatened the continued functioning of the cults. Isolation from the broader society was an effective way for Aum Shinrikyo to hide its BW-related activities, but also fermented paranoid projections of the threat to the cult posed by Japanese institutions and outside powers like the United States.

The risk that the many rather precise apocalyptic predictions by the cult's leader, Shoko Asahara, might not be fulfilled provided another incentive to 'help' events through chemical or biological weapons. The secrecy is also a consequence from the fact that in contrast to a state setting up an illegal weapons programme, a terrorist organization does not enjoy freedom from prosecution. It consequently constantly fears raids from law enforcement officials on its premises. As regards norms, it would be a mistake to assume that a terrorist organization operates in a moral vacuum. Nevertheless, as a consequence of its isolation from society the moral values will increasingly deviate and gradually allow certain courses of action a member may not have considered when joining the group. Asahara's apocalyptic visions, for instance, provided the appropriate social discourse for the new technology within the religious community, while the new technology in turn also helped to determine the genesis of the apocalypse. The question must also be raised whether an existential threat, especially one which is gradually building up and which the group feels it cannot manage, contributes to the erosion of whatever norms the group might abide by. The Rajneesh cult decided on the dissemination of salmonella in salad bars precisely to avert such a situation. Aum Shinrikyo executed sarin attacks in the Tokyo underground to divert the attention of the police, which was poised to raid the cult's facilities.

- *structure of the organization*: the available evidence strongly suggests that the most advanced programmes for large-scale dissemination of biological agents require a vertically, highly integrated and ideologically uniform group. Religious cults, like Aum Shinrikyo or the Rajneesh, are the most likely candidates. In contrast, a loosely structured, amorphous grouping with little central guidance (e.g., many transient right-wing groups and militias in Europe and the United States, including the abortion clinic attackers and the Oklahoma City bombers)[32] or an organization structured in small cells for maximum security will find it much harder to set up an indigenous CB armament programme. Such groups or even lone individuals can produce small quantities of even high grade agents. While this broadens the possibility of these agents being used in terrorist attacks, the probability and projection of consequences must nonetheless be linked to the goal–instrument relationship maintained by the actor.
- *priority resource allocation*: If a terrorist organization has ambitious plans it will have to make some key decisions regarding the priority allocation of its resources. The issue was insignificant for the Rajneesh cult. Aum Shinrikyo, in contrast, sought to destabilize Japan and eventually take over all its governmental functions. To this end, the cult pursued a broad set of instruments, including conventional weapons, an earthquake machine, a laser gun, a nuclear device, as well as CBW. It spread its huge

> financial assets and other resources over several weapon programmes as it tried to become self-sufficient in every area. (Many accounts link the cult's wealth only to its chemical and biological projects.) Each project created its own follow-on imperatives by making greater demands on manpower, the ability of the offices outside Japan to purchase the required technologies, and so on. As noted earlier, had Aum Shinrikyo concentrated its resources more on the CBW programmes, it might have achieved greater success in terms of creating a viable biological agents or larger production batches of higher-quality chemical warfare agents. As it turned out, the sect had some success in few of its weapon programmes, but its ambitions made it necessary to pursue many tracks simultaneously.

The assimilation model reveals complex processes at work in inside a terrorist organization seeking a biological capability. The picture is only partially reassuring, as partial failures and successes can still cause considerable harm to societies, although not in the catastrophic ways of some projections. This threat is arguably more pronounced for toxic chemicals, as even an agent with low concentration can kill or otherwise harm many people. In contrast, deficiencies with regard to the development and production of pathogens and toxins may not yield any active biological agent.

The most interesting phenomenon that emerges from the analysis is that several key elements promoting the armament dynamic actually contribute its failure. The projection of extreme existential threats within Aum Shinrikyo facilitated the justification of BW to some key members, but the paranoia also generated pressures to use the agents before they were fully developed. As a consequence they were relegated from strategic use in support of taking over the government of Japan to pressing tactical goals. Similarly, the sense of power that the BW conveyed to the cult and its leader in particular increased the pressure to use these not yet fully developed weapons in order to demonstrate that power internally and to the society outside. The apocalyptic visions and the requirement that rather precise predictions be fulfilled was a particularly strong pressure in this respect. Finally, the internal competition as a consequence of the resource priority allocation increased pressure upon the individuals responsible for a particular weapon programme to demonstrate success early. In the case of Aum Shinrikyo, such pressures were reinforced by Asahara's policy of favouritism. The early releases of biological agents and the nerve agent sarin (notably in Matsumoto against judges who were expected to rule against the cult) were a direct consequence of these types of pressure, and were instrumental to their shift from strategic to tactical weapons. The pressures also contributed to instances of 'technological overkill', as in the use of the nerve agent VX in assassination operations.

As is the case with states, many more terrorist or criminal entities may have pursued chemical or biological capabilities, but abandoned their efforts in the face of mountain obstacles and a diminishing rationale for their employment.

The armament dynamic and supply-side non-proliferation policies

The fear of CBW proliferation has constantly increased since the confirmation of Iraq's use of chemical weapons in the war against Iran and against its own Kurdish population in the 1980s. The uncovering in 1989 of a global web of deceit set up by Libya and a West German company in order to build a large CW plant in Rabta illustrated the complexity of the business arrangements that were being set up in order to acquire chemical or biological warfare capabilities.[33] Since the conclusion of the CWC, BW have been presented as the more salient threat, a perception that has been reinforced by the failure to equip the BTWC with verification and enforcement mechanisms similar to those in the CWC. BW concerns relate to new states acquiring such weapons, on the one hand, and to terrorists or criminal organizations resorting to pathogens to inflict mass casualties or cause serious economic or societal disruption, on the other hand. In addition, there is a natural diffusion of biology and biotechnology across the planet, which offers many developing countries concrete promises of improving the health and food security of their societies as well as prospects of economic and technological progress. However, many policy makers and analysts also fear that this spreading availability of knowledge, expertise, information, equipment and products potentially offers more states and individuals the capability to set up future BW programmes.

In the light of the intrinsic weaknesses of the BTWC and the slowness of the negotiation of the CWC a significant paradigm shift from disarmament towards non-proliferation to deal with the CBW threat took place during the late 1980s and early 1990s. The creation of non-proliferation arrangements—the Australia Group (1985) and the short-lived Leipzig arrangement (1987), which brought together members of the Council for Mutual Economic Assistance (CMEA or Comecon)—was a response to the involvement of countries from several industrialized states in Iraq's unconventional weapon programmes.[34] At the time they were viewed as temporary measures to slow the proliferation process and gain time for a successful conclusion of the CW disarmament negotiations. However, the slow progress at the Conference on Disarmament strengthened calls to create an interim CW non-proliferation regime, but such proposals were still successfully resisted at the Government–Industry Conference Against Chemical Weapons, held in Canberra in September 1989.[35] Meanwhile, the Australia Group list of controlled chemicals had gradually expanded and been extended to include BW-relevant materials too. By the time the negotiation of the CWC was coming to a close in 1992, the arrangement had become more difficult to discard and its participants only committed themselves to review their export control regulations in the light of their obligations under the CWC.[36] They signalled that both the BTWC and the CWC required further development before the export licensing measures as agreed within the Australia Group could be reconsidered.[37]

These developments have contributed to the emergence of a supply-side perspective of the security risks posed by BW, which concentrates on the organization and execution of the technology transfers and ways of preventing potential or actual proliferators from acquiring certain BW-relevant technologies. From this viewpoint, four basic transfer processes in support of a BW programme can be envisaged:

- Biological munitions are transferred from one economic unit to another (e.g., two states or from a state to a terrorist organization). However, few, if any such cases are known[38] and the trade in BW is not central to the current proliferation debate.
- The supplier provides the recipient with dual-use technologies in full knowledge that the latter seeks to acquire BW. In this case, not the actual munitions, but technologies that occupy a lower stage in the production process are delivered.
- The supplier provides the recipient with dual-use technologies, but is unaware that the latter will adapt them for a BW armament programme.
- The supplier provides the recipient with dual-use technologies and the latter applies them for the originally intended non-military purposes. The recipient builds up its technological base and may much later decide to seek a BW capability using its indigenous technological base.

As explained in the previous sections, technology transfers play a key role in armament dynamics. The most prominent reason for such transfers are deficiencies in the material base that the political entity's leadership can address only through long-term policy development and major investments. If the deficiencies occur in the physical base, then it may be impossible to effect changes. Importation of the missing ingredients is therefore likely to be fastest and cheapest way of overcoming these types of thresholds. Based on the insights into how a state or non-state actor may structure its armament dynamic in order to acquire an operational biological capability, the assimilation model reveals two important implications for arms control and non-proliferation policies based solely on supply controls.

First, supply controls raise the cost of the weapon programme, especially if there are few or no alternative sources for the missing ingredient. The question for the proliferator, however, is whether the increased cost of importation exceeds that of indigenous development. If not, the proliferator 'simply' incurs a higher opportunity cost for certain aspects of its weapon programme. This may contribute to an end product that is different from the originally envisaged one (e.g., lower quality, impact of alternative production methods, etc.), but it does not affect the demand for the weapon.

Second, it follows from the previous point that supply controls do not address the cause nor remove the political commitment to the armament dynamic. In his speech to the UN General Assembly on 1 November 2004, Dr Mohamed ElBaradei, Director General of the International Atomic Energy Agency (IAEA), pointed to the limitations of supply controls in the face of a strong pull of demand:

> Perhaps the most disturbing lesson to emerge from our work in Iran and Libya is the existence of an extensive illicit market for the supply of nuclear items, which clearly thrived on demand. The relative ease with which a multinational illicit network could be set up and operated demonstrates clearly the inadequacy of the present export control system, which relies on informal arrangements that are not only non-binding, but also do not include many countries with growing industrial capacity, and do not provide for any systematic sharing of information with the IAEA.[39]

Significantly, supply controls (export controls of specific goods; unilateral, multilateral or UN-mandated sanctions; and so on) may actually reinforce the political commitment to the armament dynamic. Especially if they are targeted against a specific country they are more than likely to increase the (already existing) threat perceptions and thus the perceived need for self-reliance in security affairs. These outcomes may in turn embolden the political leadership's commitment to the armament dynamic. The supply controls may actually reduce the thresholds for certain other aspects of the weapon programme as a result of, for example, increased budgets and re-prioritized resources. It also becomes easier to justify the weapon programme to different constituencies (the public, scientists, etc.) through processes such as the nationalization of ethics and to remove concerns about the violation of international norms by presenting the supply controls as an existential threat to the state. Such dynamics clearly drove the CBW programmes in Iran, Iraq and South Africa.

Perhaps the greatest weakness of supply-side control policies is the inability to trace the actual application of technologies after their transfer. With respect to nuclear and chemical weapons, there exist some mechanisms for onsite inspections within the framework of international agreements that mitigate the concern to some degree. The problems and the limitations in its mandate the IAEA faces have been the subject of much discussion with regard to Iran, Iraq and North Korea. The CWC machinery to track and verify the transfer of scheduled chemicals under Article VI are rudimentary, despite the fact that they will inevitably take up a more central position in a later phase of the implementation of the convention.[40] In the case of BW-relevant technologies, there are no such mechanisms at present and there is little hope that the international community will move towards creating the necessary verification machinery for the BTWC before the 7th Review Conference in 2011. The following sections outline a concept to manage BW-relevant technology transfers that might be gradually achieved without prolonged multilateral negotiations and with the direct involvement of the biotechnology industry and the relevant scientific communities.

The 'dual-use' concept

The dual-use nature of many technologies relevant to the research, development and production of BW occupies a central place in the literature on possible verification measures for the BTWC. In its most common understanding in arms control and disarmament studies 'dual use' means that technology intended for civilian application can also be used for military purposes (spin-on) or vice versa (spin-off). However, the development of a control regime for dual-use technology requires a fuller understanding of the concept and its component terms. Since most of the technology needed in the research and development and the production of BW has widespread civilian uses, the task of ensuring that those activities are compliant with the norms against the weaponization of disease is complex. Two characteristics unique to biological weapons make this goal even harder to achieve:

- the active ingredient of the weapon (i.e., the biological agent) is central to the making of the offensive weapon as well as to the development of some key means to protect against or manage the consequences of exposure to the biological agent (e.g., vaccines and medication); and
- the final stage of the armament dynamic during which the applied technologies have undeniably no other purpose than weaponization may not become apparent until the biological agent is filled into a delivery system.[41]

In the framework of a future transparency regime, it is worthwhile to preserve the concept of the general purpose criterion in Article I of the BTWC. Microbes, other infective substances or toxins are not considered as biological warfare agents if they are used for any the three permitted purposes, namely prophylaxis, protection or other peaceful purposes.[42] The GPC covers not only past and present agents, but also future ones, irrespective of whether they are of natural or synthetic origin. The convention also states that those infective agents and toxins cannot be retained in quantities that have no justification for prophylactic, protective or other peaceful purposes. However, the international community never established such quantitative thresholds. As one author argued, 'quantities for peaceful purposes cannot be defined independently of the particular circumstances of their use'.[43] With the GPC in mind, the core goal of a transparency regime is to generate context for the activities that take place in research laboratories, production installations, etc., so that the international community can satisfy itself that nothing is being undertaking that violates the norms against the weaponization of disease. Such generation of context implies the monitoring of purpose. To set up the necessary mechanisms it is important to clearly understand the concept of 'technology' and how the concept of 'dual use' relates to 'technology'.

Towards an understanding of dual-use technology transfers

Technology is usually viewed as an artifact, whether it is an end product or a tool applied to attain an end product. However, it involves more than just products; it also encompasses the means to conceptualize and produce these products in response to a particular technical problem and the ability to use them in an effective way to solve that problem. Based on this understanding, technology can be defined as comprising 'the ability to recognize technical problems, the ability to develop new concepts and tangible solutions to technical problems, the concepts and tangibles developed to solve technical problems, and the ability to exploit the concepts and tangibles in an effective way'.[44] In other words, technology involves not only materials and artifacts, but also capital, knowledge and skills, as well as principles, techniques and systems for the management of research, development and production processes.[45] Dual-use technology is then technology that 'has *current or potential* military *and* civilian applications'.[46] A dual-use transfer occurs whenever a technology is used for a civilian or military purpose that differs from the one that was originally envisaged. This transfer can take place inside an economic unit (e.g., a research institute or a company) or between economic units (e.g., following a sale).

In addition to the understanding of 'dual-use transfer', the relationship between 'dual use' and 'technology' requires clarification as its conceptualization has a major bearing on the nature of future control and transparency regimes. The core question is whether 'dual use' is an intrinsic feature of technology or whether it is an attribute, whose potential is realized depending on circumstances.

If it is an intrinsic feature, then the technology itself constitutes a source of threat. The consequence is that all technology needs to be controlled in order to avoid their possible diversion for BW development and production. The list of items that needs to be controlled becomes endless. On the one hand, as the state or non-state entity that seeks such a weapons capability will attempt to develop certain enabling factors in the material base in order to reduce the import dependency it will gradually be able to draw on a broader base of technologies that are one or more steps further removed from the end product. Not only will this make the supplier less suspicious about the intent, the number of potential suppliers also increases. This understanding was central to the initial control lists for chemicals, biological agents and toxins adopted by the Australia Group. As these lists were expanded, new categories of equipment used in laboratories and production facilities were also added. In order to address the problem of potentially ever-expanding lists, the notion of catch-all regulations were introduced, whereby the exporter was required to notify the export control authorities if he knew or suspected that the ordered goods would contribute to the development of production of chemical or biological weapons. In practice, however, the policy raises some practical issues as it presupposes that the export control authority keeps the exporter informed of relevant developments in order to make the judgment possible. From the exporter's viewpoint, the policy also brings up questions about liability in case he makes a wrong judgement about the intent of the purchase. On the other hand, the exporter and the export control authorities have little insight into the ultimate purpose of the technologies once the transaction has taken place.

If, in contrast, 'dual use' is an attribute of technology whose potential is realized depending on the context in which that technology is applied, then technology only becomes problematic and threatening if it is applied in a particular context (e.g., the development or production of BW).[47] The aim of the control regime then becomes the verification of purpose rather than of technology and the prevention that a particular dual-use transfer takes place. The stress on dual-use *potential* is of importance, as a case of *technology transfer* rather than dual-use technology transfer takes place if the technology is moved across units without the intention to modify its initially envisaged application.[48] This understanding of the dual use concept opens possibilities to make the general purpose criterion in the BTWC (and respecting toxins, the CWC) operational form a policy perspective. Furthermore, under such a control regime the recipient will have to demonstrate the legitimacy of the intended application of the transferred technology, thus distributing the burden of demonstrating compliance with the norm against the weaponization of disease among all partners in the transaction. The attributive understanding of 'dual use' is central to the transparency concept proposed in this paper.

The understanding of 'dual-use' technology transfers under the BTWC

As noted earlier, the dual-use concept is often understood in the context of spin-on and spin-off effects between the civilian and military sectors. However, as regards technology transfers permitted under the BTWC, the differentiation between prohibited and non-prohibitted purposes introduced by the GPC does not coincide with the distinction between civilian and military activities. In the light of the fact that many of the civilian and most of the military permitted purposes are related to the questions of BW defence, protection and prophylaxis, the issue of technology transfer becomes a two-dimensional one (see figure 4).

The BTWC prohibits all technology transfers from the left to the right side of the figure and between the quadrants B and D are under all circumstances. Technology transfers from

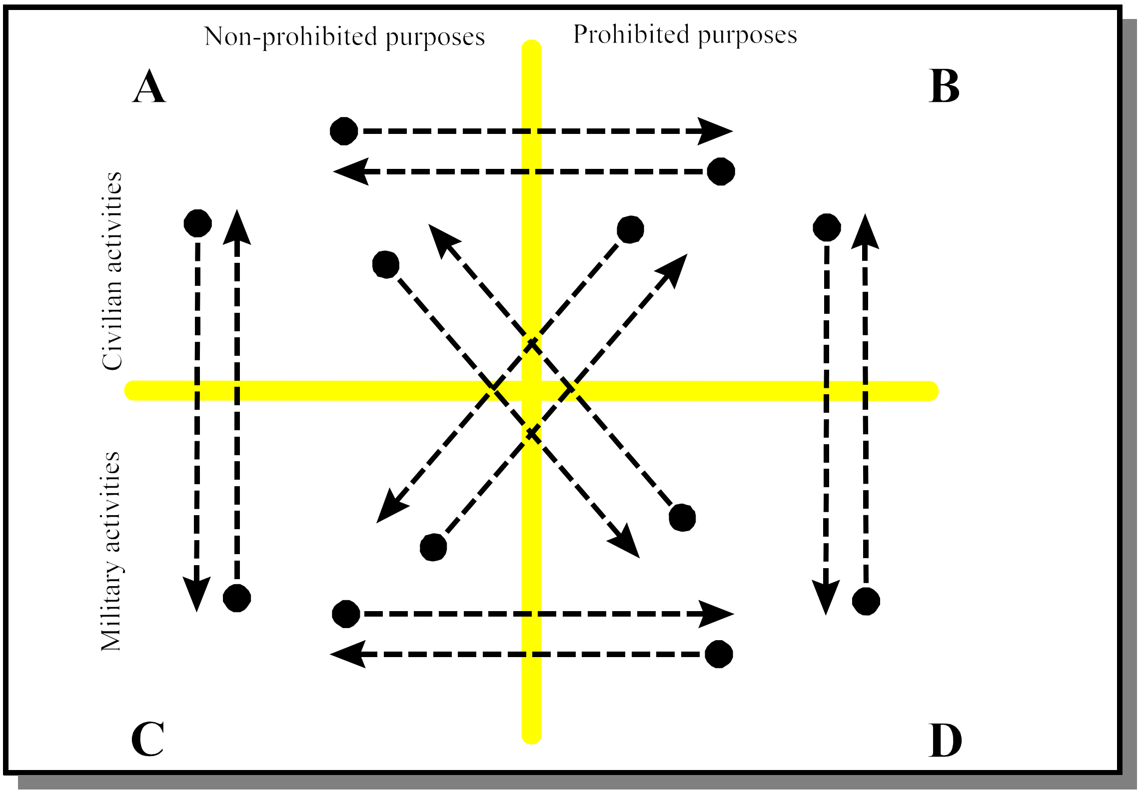

Figure 4

B and D to either A or C are permitted only once, namely for the conversion of BW-related technologies and installations for non-prohibited purposes. The window of opportunity was limited: according to Article II of the BTWC such conversion should take place as soon as possible, but not later than nine months after entry into force of the convention. As the BTWC does not make any formal distinction between civilian and military activities, it does not constrain technology transfers between A and C as they serve the specified non-prohibited purposes. The dual-use potential of the technologies in these civilian and military activities can be exploited to the fullest. Advances in the civilian sector can benefit the goal of improved defence, protection and prophylaxis, while some of the research and products from the military sector can serve society as a whole.

The real challenge for a future regime against the weaponization of disease lies in the fact that many beneficial technologies developed in A and C can be directly applied in offensive BW programmes or involve the study of the offensive aspects of biological warfare. While the dual-use potential of the relevant technologies may not be realized today, the resort to off-the-shelf technology to quickly acquire BW in a future conflict is not beyond imagination.[49]

The organization of transparency

The proposed novel concept for generating transparency with regard to biotechnology transfers across national borders and inside a single country draws on the insights regarding the structuring of the armament dynamic and the proposed understanding of 'dual-use technology transfers'. Given the nature and the rapid development pace of the different types of biotechnologies, it is clear that the slow process of multilateral negotiations is unlikely to produce an adequate answer to the challenge of the potential misuse of these technologies for hostile purposes. In any case, the current international climate is not favourable to the strengthening of verification and compliance enforcement of the BTWC by means of a new legally binding document. In addition, as the demand side analysis of the armament dynamic underlines that the organization of a biological weapon programme in a state or a terrorist organization involves different levels of activities and responsibilities, there is a need to involve actors on other levels than that of the state as active partners in the prevention of BW proliferation and armament. Although the realization of the transparency model may be considered outside the BTWC framework, it nonetheless remains important to emphasize that the prohibitions of the convention are at its core.

Central to the proposed concept is the principle of accreditation, which embodies the formal recognition that an economic unit meets internationally agreed standards of transparency. As a result, all concerned parties—the economic units, relevant government agencies, and the international community—can have a high degree of confidence in the legitimacy of technology transfers between accredited economic units. The concept offers the prospect of economic benefits for the accredited economic units: the knowledge that they are unlikely to misuse the technology for purposes prohibited under the BTWC makes it possible to simplify the controls on the transfers between them. Meanwhile, government authorities retain a significant control instrument as a violation of the criteria may lead to withdrawal of the accreditation, and hence of the economic benefits.

The technology transfer concept is based on the action and interaction of three agencies, namely the economic unit as the principal actor in the technology transfer, an international organization primarily responsible for setting the accreditation criteria and overviewing the application of the common standards, and a national authority responsible for the accreditation of economic units and supervising the maintenance of the accreditation standards.

The accreditation process

Accreditation is the central concept of this model. In essence, it is the commitment by an economic unit that it will abide by internationally set standards and participate in a regime to generate transparency regarding biotechnology transfers. In contrast to supply-side models to control technology transfers (e.g., export controls), the accreditation mechanism places equal responsibility to generate transparency about transactions on the supplier and the recipient. In particular, as the recipient must also meet the accreditation criteria, it will be possible to watch over the application of the transferred technology for non-prohibited purposes after the transaction has been completed. The same principles apply to re-transfers to third parties. The accreditation mechanism thus creates a workable system of matching import and export controls. Accreditation would also apply to exchanges of scientists and other skilled personnel, hence the need to include research units in the model. Such exchanges contribute significantly to transparency, because they are among the first people who would detect suspicious activities or implausibilities in official explanations for a particular setup of a laboratory or other research unit.

In summary, an international organization sets the accreditation standards and a national authority in the countries participating in the technology transfer scheme will be responsible for the actual accreditation of individual economic units and primary verification of the implementation of the accreditation standards (see figure 5).

The biotechnology sector, operating in an internationally highly competitive environment, has a keen interest in a level playing field whereby all actors are subject to similar regulations, incur similar costs for implementing those regulations, and have the prospect

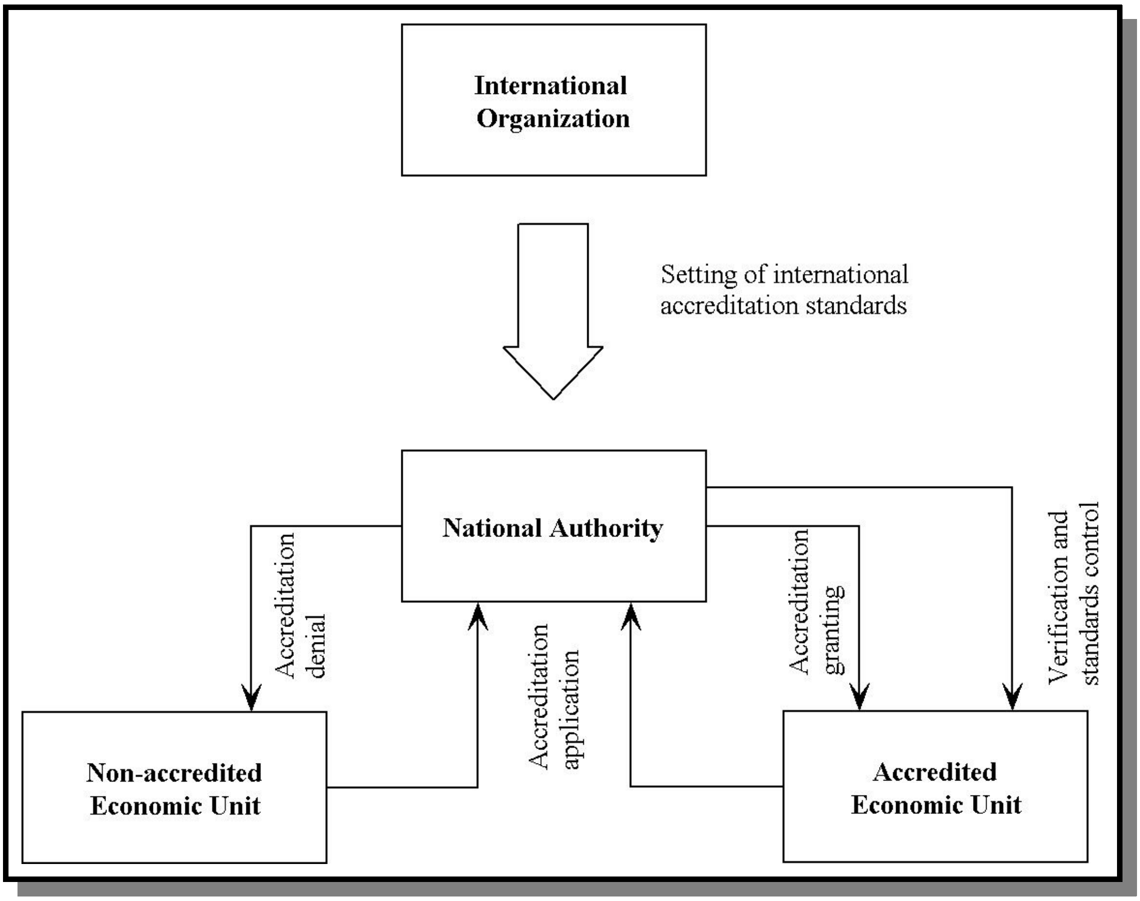

Figure 5

of equivalent benefits. To this end, an international organization is required to draw up the list of international standards and obligations for the economic units. There are different formats for the international organization possible (see below).

Economic units decide for themselves whether they apply for accreditation to the national authority of the country in which they are located. The benefits are simplified technology transfer procedures, resulting in reduced costs for executing the transaction. However, it is conceivable that a particular economic unit has valid reasons not to participate in this arrangement. In that case, technology transfer controls maintained by the country in which the unit is located would apply, so that the country would not be in breach of the non-proliferation obligation in the BTWC (Article III).[50] Nevertheless, the accreditation principle should be designed in such a way that the economic units can discern clear benefits in order to ensure that the greatest possible number of them participates in the system.

The penalty for not meeting the obligations is losing the accreditation, and all the benefits that accompany it. The national authority must regularly certify that the economic unit meets all the standards in order to extend the accreditation.

International organization

The international organization plays a central role in the determination of the common accreditation criteria for all economic units irrespective of their location. It also has important monitoring and enforcement tasks. The precise nature of the future organization still remains to be determined. While its creation as a body to oversee the implementation of the BTWC presents certain clear advantages, the multilateral negotiation of new disarmament agreements is currently at an impasse. The climate may not change significantly over the next five years. Alternatives include initiatives undertaken by some states parties to the BTWC that discern a clear benefit in the concept, by the industry, or a mixed government–industry body. The major challenge in constructing the right type of international organization is to strike an optimal balance between ensuring the public good of security and respecting the legitimate scientific and commercial interests of the biotechnology sector while meeting the core obligations of the BTWC.

The form of the international organization will have a significant influence over its precise functions. Notwithstanding, certain major areas of responsibility can already be identified.

Establishing accreditation criteria

The international organization establishes and modifies the criteria for the accreditation of all types of economic units that participate in the technology transfers.

It is imperative that the criteria apply equally to all parties concerned. In this way it becomes possible to bridge the gap regarding non-proliferation priorities versus the right of access to technology between developed and developing countries. Furthermore, the internationally determined criteria will also level the playing field for competition among the economic units. Non-accredited units would actually suffer a double penalty in that they would find it harder to transfer or receive relevant technologies (see the discussion of transfer flows below).

Monitoring of transfer flows

Based on aggregate data of technology transfers submitted by the national authorities the international organization will monitor technology transfer flows. It is anticipated that after a certain period patterns will emerge and that anomalies in technology flows as well as inconsistencies with national declarations (for instance, under the confidence-building measures) can be detected.

Depending on the type of technology to be transferred, the reporting time frames will vary. For certain particularly dangerous pathogens, one could envisage advance notification. For other technologies quarterly, half-yearly, and annual submissions can be envisaged.

Anomalies become the subject of clarification requests and consultations. If no satisfactory explanation is forthcoming, they could lead to different types of inspection, depending on the nature and seriousness of the anomaly.

Analysis and evaluation

The international organization must have an analysis unit to study the submissions by the national authorities, otherwise it cannot execute its monitoring tasks. However, it should also have the authority to conducts its own research and analysis of open sources in order to gain better insight into the prevailing technology transfer patterns. Such authority will contribute to the international organization's capabilities to assess the national submissions. One can also envision that the international organization receives intelligence information from states parties (analogous to the International Atomic Energy Agency), although the utility of such information may be greater for other types of verification than for the monitoring of transfer flows.

Inspectorate

The international organization will have a limited inspectorate for the purpose of monitoring and verifying technology transfers. With regard to technology transfers, they will conduct inspections in states parties if the consultative means of resolving concerns about technology transfers do not produce a satisfactory outcome. Different types of inspection can be envisaged, depending on the nature of the concern.

National implementation assistance

The international organization can assist economic units in member states to achieve the standards required for accreditation and facilitate bilateral coordination between member states or economic units for the same purpose.[51] Similar assistance can be given to states parties with regard to setting up and running the national authority, and to establishing national technology transfer controls for transactions involving non-accredited economic units.[52] These could be developed as new initiatives to implement Article X of the BTWC.

National authority

The national authority plays the central role with regard to guaranteeing the transparency of all relevant transactions originating from its territory to the international community. It collects all required information from the relevant economic units and processes it in order to submit the aggregate data to the international organization. The data collection also applies to transfers inside the state borders.

The national authority accredits economic units and develops the necessary activities to certify on a regular basis that the economic units continue to meet the standards for accreditation. Failure to do so could lead to calls for inspections by the international organization.

It acts as the focal point for the international organization and the national authority of other countries, and is the first contact point in the case of inconsistencies or compliance concerns (which may be resolved on a bilateral basis or through mediation of the international organization).

It has prime responsibility for granting or denying export licenses to non-accredited economic units or economic units located in non-state parties. To this end, it develops or plays a key role in the development of national technology transfer regulations that would apply to transactions involving a non-accredited economic unit and informs the international organization of such regulations. In principle, the greatest degree of harmony regarding such regulations should be pursued among states parties (the international organization can play a coordinating role and make recommendations).

Making the national authority the central pillar of the system and the main interactant with the industry located in the country should help to reduce industry concerns about the potential loss of propriety information. In order to execute its tasks the national authority would need—in addition to the staff required for data collection and processing—a group of inspectors in support of the accreditation procedures. To the industry and other economic units, the disruption to ongoing activities and the risk of losing sensitive information should not be any greater than those resulting from, for example, health and safety inspections.

The generation of transparency

The technology transfer model works on different levels. Units on each level have specific sets of responsibilities with regard to the generation of transparency and confidence in the legitimacy of business transactions (see figure 6).

Accredited economic units are central elements in the model. They become active partners in the generation of transparency and in return obtain trade benefits in the form of simplified procedures to pursue trade opportunities. They can also have increased confidence in the legitimacy of the transaction and thus avoid to have their reputation inadvertently tarnished. Through their regular, if not permanent interaction with the national authority they updated on security developments and their responsibilities and obligations. These interactions will also ensure that in the development of the regulatory and control mechanisms legitimate business interests can be taken into consideration. They will be greatly facilitated by the creation of an implementation office that serves as point of contact for the national authority. A accredited economic unit must meet the accreditation criteria

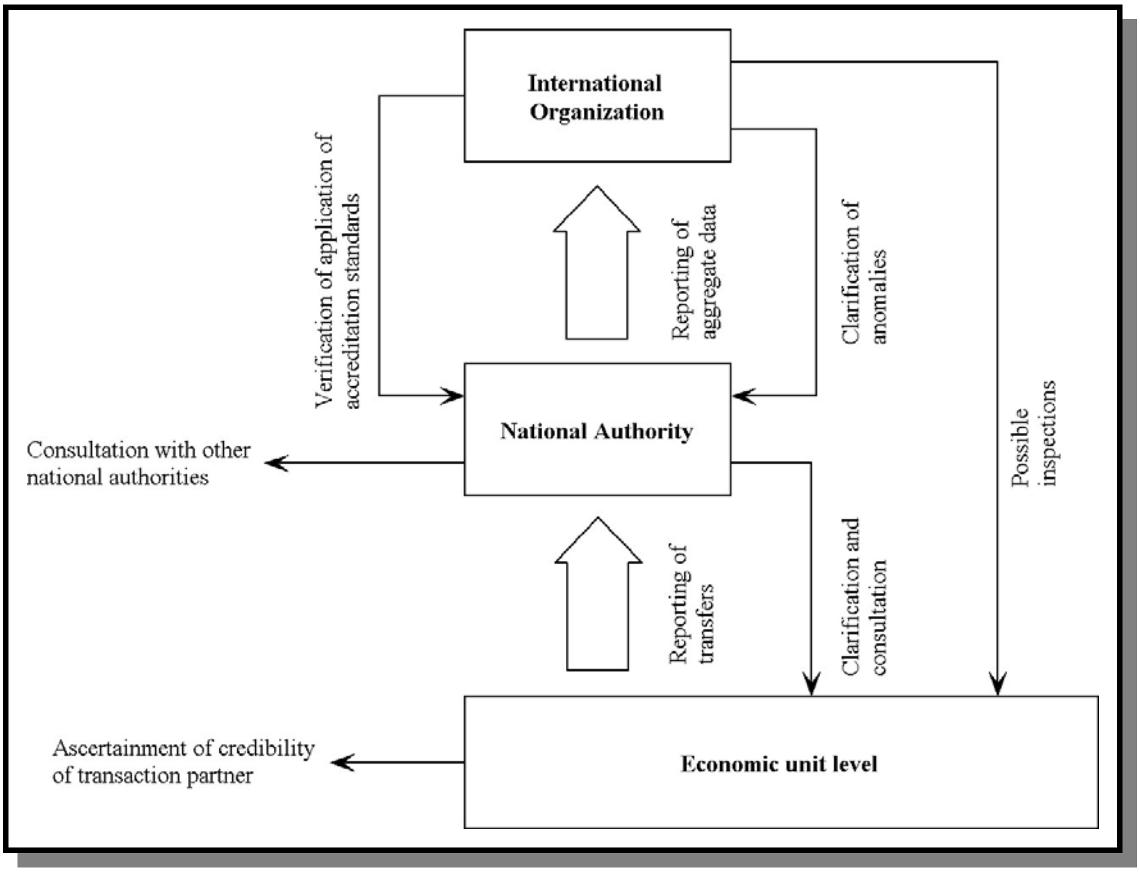

Figure 6

for transparency and accept the verification procedures involving national or international inspectors. The implementation office must have high-level authority to ensure compliance with the accreditation standards by all branches of the economic unit. It bears the responsibility to ascertain itself of the credibility of a potential trade partner. If the transaction is to go ahead, it reports the transfer to the national authority as a supplier or recipient.

The *national authority* is the pillar of the system, because of its central responsibility in accrediting economic units. It collects and processes information on national and international technology transfers and resolves inconsistencies on the economic unit level. The national authority can inspect economic units. It reports aggregate date on technology transfers to the international organization. For all relevant matters, it liaises with the international organization and the national authorities of other countries. It regularly verifies the compliance of economic units with the accreditation requirements and renews or withdraws the accreditation based on its evaluation.

The precise responsibilities of the *international organization* will depend on its structure and composition. Nevertheless, among its tasks must be the analysis of the aggregate data submitted by the national authorities. It also conducts its own open source research and analysis in order to be able to establish a reference framework for its own evaluations. It sets up procedures to resolve anomalies and inconsistencies. These include clarification and consultation with the national authorities and the ability to conduct its own inspections in economic units. Ultimately, it needs to ascertain itself that the national authorities correctly administer the accreditation process.

Technology transfer flows

There are several types of possible technology transfer relations depending on whether the transaction takes place between accredited economic units, between an accredited and a non-accredited economic units, or between non-accredited economic units. Furthermore, non-accredited economic units can be located in states that are not party to the BTWC or do not participate in the proposed technology transfer regime. The resulting technology flows, which may take place inside the borders of a single state or across national borders, are:

- *Between accredited economic units*

  This type of technology transfer is the easiest to conduct as the greatest degree of transparency about the transfer and end use is guaranteed. Agreed reporting requirements will be operational. In order for the principle of matching import and export controls to function both the supplier and the recipient must report the transaction to their respective national authorities within the specified time frames.

- *Between an accredited and non-accredited economic unit*

  Either the recipient or the supplier is a non-accredited economic unit.

  In the case the recipient is a non-accredited trading partner, then the supplier is required provide the national authority with sufficient information about the recipient in addition to normally required data. The national authority will act on this information by either granting or denying the transfer based on relevant national technology transfer regulations. It will also notify the national authority of the recipient's country if it allows the transaction to go ahead. Upon fulfilment of the contract the national authority of the non-accredited recipient will inform its counterpart in the supplying country of the arrival of the goods. It may also undertake further steps based on national regulations to ascertain itself of the purpose of the imported technology.

  In the case the supplier is not accredited then its national authority will grant or deny the transfer based on relevant national regulations. The recipient must provide its national authority with all normally required data about the transfer within specified time frames and sufficient information about its trading partner. The national authority will inform its counterpart in the country from which the transaction originates.

  A similar procedure needs to be devised for transfers involving a non-accredited economic unit inside a country, so that based on national laws and regulations the national authority can validate the purpose of the application of the technology.

  There are grounds to expect that if the technology transfer system is sufficiently widespread the number of technology transactions pursued by accredited economic units with non-accredited counterparts will decline as a consequence of the administrative procedures, delays and uncertainties regarding licensing decisions. This development may act as an incentive for economic units to seek accreditation.
- *Between non-accredited economic units*

  If neither economic unit is accredited, then the immediate involvement of the respective national authorities increases considerably. On the supplier's side the national authority grants or denies the export license application based on relevant national technology transfer regulations and inform its counterpart in the recipient's country.

  The recipient's national authority will seek confirmation that the transaction has taken place and inform its counterpart in the supplier's country. It may also undertake further steps based on national regulations to ascertain itself of the purpose of the imported technology.

- *Involving an economic unit located in a state not party to the BTWC*
  The way in which this particular issue will manifest itself depends on whether the technology transfer model will be wholly realized within the BTWC framework or not. In the case of a full intergovernmental organization, certain technology denials to non-states parties may be included in the legally binding document that will supplement the BTWC (similar to the transfer of toxic chemicals listed in the Schedules of the CWC). The considerations may be different if the international organization is set up as an industry initiative or as a mixed government-industry undertaking.

  Denial of particular technology transfers on the basis of non-membership of the international organization could pose ethical questions in the case of, for example, health emergencies. The current debates on the emerging BW threats interact with other issues, such as emerging and re-emerging diseases or environmental degradation, that touch societies in all parts of the world. Because of the role biotechnology plays and will play in the development of a society, the technology transfer model will also affect the sectors of economic, political and societal security. If the model can be successfully promoted as an initiative to implement Article X of the BTWC, then the interest of many countries to participate in the convention would then be determined not by BW threats, but by, for example, the right to participate in international exchanges and to have access to the new biotechnologies that could help them to counter their societal threats and enhance their economic, environmental and political security.

  States can obtain many of the prospective benefits through other international organizations or arrangements, like the World Health Organization (WHO), the World Trade Organization (WTO) or the Convention of Biological Diversity. From the perspective of the proposed model, there is an interest to make those transfers as transparent as possible in order to prevent the misapplication of biotechnology for prohibited purposes.

  In summary, the technology transfer model proposes not to deny transfers to non-states parties out of hand, but to subject them to national export regulations and national decisions on a case by case basis. Details of such transfers would be reported to the international organization. Regular transfers could also taken under consideration, but stricter transfer controls would be applicable. Avoidance of this administrative burden could be advanced as an incentive for the recipient state to join the BTWC.

Conclusion

Proliferation studies principally focus on the transfer patterns of tangible objects, such as agents and equipment, and the threat of the immediate realization of their dual-use potential, whereby the recipient countries (or sub-state actors) of concern acquire technology developed for civilian use and instantly apply it for the purpose of acquiring BW. Yet, at the core of the biotechnological revolution is information: data collection and processing, knowledge, techniques and skills. Moreover, biotechnology produces enabling technologies for many civilian applications that contribute to future information accumulation and product and process improvements. This information core permeates the society in which the development takes place. However, with today's globalization and growing interdependence it inevitably diffuses across national borders. While lateral proliferation processes are undeniably taking place, the greatest challenge to the efforts to prevent biological warfare may actually come from a sudden massive application of civilian biotechnology for the purpose of acquiring a biological warfare capability in a state party facing a serious security threat. This possibility will require new mechanisms to deal with the instant realization of the dual-use potential of biotechnology within a state party. In addition to the traditional verification and monitoring of the destruction and non-production of BW in states parties, any future regime will have to incorporate an understanding of biotechnology and technology transfer processes that goes beyond mere products (agents, production equipment, etc.).

The aim of proposed set of tools is to render transparent technology transfers between economic units (e.g., individuals, laboratories, companies, etc.) within a state party and between economic units across national boundaries (including states and transnational companies and organizations). All economic units involved in a transaction will share the responsibility of ensuring that the dual-use potential of the technologies is not realized. The explicit commitment by the economic unit, whether a supplier or a recipient, to uphold this responsibility will then become a key component for granting the transfer license. The principle also applies to scientific and student exchanges as in-depth background knowledge will enhance the transparency about the institute's and the individual's activities. The operation of the mechanisms on the level of the laboratory, industrial unit or other type of facility will contribute to the generation of contextual data from inside those facilities, which in turn will assist in the determination whether those activities are legitimate or illegitimate. National authorities and an international organization (whatever form it may take) will monitor the transparency of all relevant technology transfers.

The proposed concept rests on three pillars:

- an armament dynamic is a complex process, whose outcome is not predetermined. Furthermore the precise structure of the dynamic is virtually unique to each political entity, whether a state or non-state actor. The demand-side analysis highlights that the importation of technology is but one way of structuring the armament dynamic. However, in the short run it may be the fastest and cheapest way to overcome certain deficiencies in the material base. This insight underscores the insufficiency of supply-side controls only to prevent the proliferation of BW: they do not address the basic motivation for the weapon programme. In addition, they may actually strengthen the commitment to the initial decision to acquire the weaponry by reinforcing external threat perceptions and stimulate the dynamic lowering certain thresholds.
- the understanding that 'dual use' is an attribute rather than an intrinsic property of technology, whose potential may be realized depending on certain contextual factors. This understanding enables the operationalization of the general purpose criterion in the BTWC (and CWC).
- the need to have the industry and the scientific communities actively involved in transfer process, whether as the supplier or recipient of technology. On the one hand, their adoption and application of the accreditation criteria will significantly contribute to the generation of transparency and hence the confidence in the legitimacy of the activities and raise significant barriers against states or non-state entities acquiring a biological capability. On the other hand, the application of the concept will confront scientists, technicians and other professionals with their individual and collective responsibilities towards the norm against the weaponization of disease on a continuous basis. It lays a solid foundation for the development and application of ethical standards and professional codes of conduct so that no individual or economic unit can claim ignorance of the core prohibitions. This outcome alone will significantly raise certain key thresholds, complicating the launch and maintenance of a BW armament dynamic.

This set of tools will nonetheless have to be supplemented with extensive positive security guarantees in order to reduce the disproportionate military advantage a state party might gain from defecting from the BTWC. These guarantees do not solely entail the right of access to assistance and protection (subject to the transparency conditions mentioned above), but also involve dynamic decision-making procedures in order to be able to respond swiftly and decisively in the case of a rapidly developing crisis. If adequately implemented, the mechanisms to enhance the transparency of technology transfers may be able to provide sufficient advance warning of an impending massive transfer of civilian technology for prohibited purposes.

Notes

1 Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, opened for signature at London, Moscow and Washington on 10 April 1972 and entered into force on 26 March 1975.

2 Final Document, Fourth Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, document BWC/CONF.IV/9, 6 December 1996, p. 15, para. 6:

> The Conference, conscious of apprehensions arising from relevant scientific and technological developments, inter alia, in the fields of microbiology, biotechnology, molecular biology, genetic engineering, and any applications resulting from genome studies, and the possibilities of their use for purposes inconsistent with the objectives and the provisions of the Convention, reaffirms that the undertaking given by the States Parties in Article I applies to all such developments.

3 Bartfai, T., Lundin, S. J. and Rybeck, B., 'Benefits and threats of developments in biotechnology and genetic engineering', *SIPRI Yearbook 1993: World Armaments and Disarmament* (Oxford University Press: Oxford, 1993), pp. 293–305; Dando, M., 'Benefits and threats of developments in biotechnology and genetic engineering', *SIPRI Yearbook 1999: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1993), pp. 569–611; and BioWeapons Prevention Project, *BioWeapons Report 2004* (BioWeapons Prevention Project: Geneva, 2004), pp. 51–66 and 103–114.

4 Article X of the BTWC states:

> (1) The States Parties to this Convention undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes. Parties to the Convention in a position to do so shall also cooperate in contributing individually or together with other States or international organizations to the further development and application of scientific discoveries in the field of bacteriology (biology) for prevention of disease, or for other peaceful purposes.
>
> (2) This Convention shall be implemented in a manner designed to avoid hampering the economic or technological development of States Parties to the Convention or international cooperation in the field of peaceful bacteriological (biological) activities, including the international exchange of bacteriological (biological) and toxins and equipment for the processing, use or production of bacteriological (biological) agents and toxins for peaceful purposes in accordance with the provisions of the Convention.

5 Final Document, Fourth Review Conference (note 2), p. 23, Article X, para. 1:

> The Conference once more emphasizes the increasing importance of the provisions of Article X, especially in the light of recent scientific and technological developments in the field of biotechnology, bacteriological (biological) agents and toxins with peaceful applications, which have vastly increased the potential for cooperation between States to help promote economic and social development, and scientific and technological progress, particularly in the developing countries, in conformity with their interests, needs and priorities.

6 Article III of the BTWC states:

> Each State Party to this Convention undertakes not to transfer to any recipient whatsoever, directly or indirectly, and not in any way to assist, encourage, or induce any State, group of States or international organizations to manufacture or otherwise acquire any of the agents, toxins, weapons, equipment or means of delivery specified in Article I of this Convention.

7 Zanders, J. P., 'The CWC in the context of the 1925 Geneva debates', *Nonproliferation Review*, vol. 3, no. 3 (spring–summer 1996), pp. 38–39.

8 Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 19 June 1925.

9 Commission for Conventional Armaments, Working Committee, Draft resolution submitted by the United States, UN Security Council document S/C.3/SC.3/7/Rev.1, 8 September 1947.

10 In its advisory opinion on the legality of the use by a state of nuclear weapons in armed conflict of 8 July 1996 the International Court of Justice could not conclude definitively whether 'in view of the current state of international law, and of the elements of fact at its disposal, [...] the threat or use of nuclear weapons would be lawful or unlawful in an extreme circumstance of self-defence, in which the very survival of a State would be at stake'. International Court of Justice, Advisory Opinion on the Legality of the Threat or use of Nuclear Weapons, The Hague, 8 July 1996, documents available from <http://www.fas.org/nuke/control/icj/text/index.html>.

[11] For example, Iraq only admitted to its chemical arsenal after the end of the war with Iran in 1988 despite the clear evidence of chemical warfare since 1984. India had a small, but deeply secret chemical weapon programme, which caused great surprise when its government declared it under the terms of the Chemical Weapons Convention on 26 June 1997. South Korea, in contrast, still does not admit publicly to its CW stockpile and refuses to be named in any of the OPCW documents despite the fact that its chemical weapons are being destroyed under international supervision in accordance with the country's CWC obligations. (Zanders, J. P. and Hart, J., 'Chemical and biological weapon developments and arms control', *SIPRI Yearbook 1998: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1998), pp. 460–61.) South Africa, which was widely lauded for the termination of its nuclear weapon programme, still has considerably difficulties in coming clean regarding its chemical and biological weapon programmes.

[12] SIPRI, *The Problem of Chemical and Biological Warfare, Volume IV: CB Disarmament Negotiations, 1920–1970* (Almqvist & Wiksell: Stockholm, 1971), chapters 4 and 5.

[13] Analysis of the main theoretical schools of armament dynamics with reference to chemical and biological warfare shows that the realist/neorealist, institutional imperative technological imperative approaches each highlight particular aspects of the chemical or biological weapon armament dynamic. None of them, however, is fully capable of explaining the full process because some of the critical parameters used in their construction are either missing or fundamentally different.

[14] Zanders, J. P., *Dynamics of Chemical Armament: Towards a Theory of Proliferation,* Thesis submitted in fulfilment of the degree of the requirements for the degree of Doctor (PhD) in Political Science (Vrije Universiteit Brussel: Brussels, Feb. 1996), 364p.

[15] The complex interaction between both track can be illustrated by reference to the arguments formulated in support of the US binary programme between the mid-1950s and late 1980s. The arguments to address military concerns were clearly directed towards placing the new munitions as closely as possible to the core of the military doctrine (a process that was known as the 'conventionalization of chemical warfare). Those addressing political and societal concerns aimed to lower the thresholds on the political track. (Perry Robinson, J. P., 'Binary Nerve-Gas Weapons', SIPRI, *Chemical Disarmament: New Weapons for Old* (Almqvist & Wiksell: Stockholm, 1975), p. 26; and Zanders (note 14), pp. 139–40.)

Military concerns:
- *Safety*: Safety was the original concern for developing the idea of binary delivery systems.
- *Categorisation as 'special munition'*: nerve agents demanded stringent safety precautions and were therefore categorized as special munitions along with nuclear weapons. The binary munitions offered the possibility of removing chemical weaponry from that category. As a result, they could be stored close to potential combat zones and thus become part of basic load of tactical forces.
- *Safety hazards for troops handling the munition*: because the final reaction takes place during the munition's trajectory to the target, soldiers firing the munition are not exposed to the deadly toxicant.
- *Logistical burden*: the munition can be stored nearer to the frontline. Both components are located in different areas so that enemy hits on the storage site do not release the deadly agent. Troops moving the munition to firing positions need not take elaborate precautions, such as wearing heavy protective suits, or constantly fear for their life, thus resenting the task at hand.
- *Storage safety on ships*: for the same reasons as above, binaries make seaborne transport or storage an attractive option. Chemical decontamination on a ship involves extremely complex and time-consuming procedures, a virtually non-existent risk with binaries. This may have been one of the concept's greatest attractions and contributed to the design of the Bigeye binary bomb for the US Marines.
- *Long-term storage*: agents filled into munitions degrade relatively quickly. The alternative of bulk storage, however, has the disadvantage of major delays in case of emergency contingencies. The binary munitions could address both issues simultaneously.
- *Standardisation of munition*: three types of delivery systems were ultimately proposed, the 155-mm artillery shell, the rocket for the Multiple Launch Rocket System (MLRS), and the Bigeye spray bomb. They could be launched from standard weapon systems or weaponry soon expected to enter service of several NATO armies.

Political concerns:
- *The warfare agents are not actually produced*: the argument addressed potential moral and psychological concerns of political decision-makers.
- *Peacetime forward storage*: if the argument of a Soviet CW threat had any foundation, the storage of new chemical munitions in continental USA made little sense. The binary technology therefore offered the

prospect of overcoming emotional concerns in Europe regarding peacetime deployment. (This policy track eventually backfired badly, because in order to secure domestic authorisation for production, the Reagan administration had to seek NATO approval in the form of a force goal. This added another contentious issue to the Alliance's agenda just after the deployment of the intermediate-range nuclear missiles had begun. Part of the compromise was ultimately the removal of the existing US stocks in Germany.)

Societal concerns:

- *Environmental hazards and safety of the population near storage sites*: Peacetime storage of chemical agents in bulk or filled in ammunition poses a great hazard to the environment or nearby population centres. The binary concept addressed this problem by enabling storage of the components in separate locations. Although some of these precursor compounds may still be toxic to humans, they are much less so than the final warfare agent. Separate storage also allowed lower safety standards and therefore reduces cost of maintenance and security.
- Transport safety: Separate storage of the precursors increased transport safety. Even in case of an accident, the consequences would be far less than with the chemical warfare agent itself. Reduced hazards made movement between storage sites or to destruction facilities easier.
- *Advantages for disarmament*: The destruction of binary munitions was argued to require less advanced technologies as the two binary components present less of a problem to destroy. Environmental risks, especially from some highly toxic dioxin variants posed by incineration, would be reduced.

16 In operational analysis the nature and the relative importance of the thresholds can be determined by using two types of comparative analysis:

synchronic analysis between different political entities: differences in political, social and economic organization manifest themselves in the type and height of the obstacles which will emerge during the armament dynamic. For instance, in a democracy greater energy must be invested in convincing parliamentary and extra-parliamentary opposition than in a dictatorship. A country with limited industrial development will have to seek greater help abroad. Such comparisons will consequently reveal a series of thresholds as well as their relative importance in function of the type of state structure, the material base and the political and military responses. (It should be noted that empirical analysis based on the assimilation model finds no correlation between whether a state will pursue offensive CBW and the nature of state governance (e.g., so-called rogue states versus democracies). However, the political culture does have an impact on how the armament dynamic is structured, among other things, because of the impact of public opinion on the armament dynamic. With regard to CW programmes in the Middle East, se Zanders, J. P., 'The demand side of CBW Proliferation', Schroeer, D. and Elena, M. (eds.), *Technology Transfer* (Ashgate: Aldershot, 2000), pp. 167–186.)

diachronic analysis of analogous armament programmes in a single political entity: this comparative method will not only reveal differences in the development of the political and military organization of the country, but also draw attention to the development of the material base (industry, technology, education, and so on) and its impact on historically comparable issues in the armament process.

17 Traditional armament theories do not consider failure as the analysis is mostly based on weapon systems that had already been deployed. Three theoretical outcomes exist. The variance is nil if the weapon system has been achieved as originally conceived without any (uncalculated) opportunity costs. It is infinite if the aggregate opportunity cost is too high a price to pay. For whatever reason or combination of reasons the weapon system is not produced or deployed. In most cases the variance will lie between these two extremes and reflect the deployed weapon system as the result of all opportunity costs paid. These outcomes are valid only if it is accepted that the policy proposers will try to keep the variance as small as possible, an assumption which is embedded in the assimilation process.

18 With regard to special types of weaponry a variation of the dynamic takes place, whereby the equivalent of the military doctrine is defined by the specific purpose of the weapon and from which the operational guidance is derived.

19 India's chemical munitions, for example, were not stored with the military forces and most military commanders were reportedly uninformed of the existence of the stockpile (see note 11). In other words, while the munitions existed they were not assimilated and therefore unlikely to be part of doctrinal or tactical guidance for the Indian military.

20 Graham, B., 'Interceptor system set, but doubts remain', *Washington Post*, 29 September 2004, p. A01.

21 In operational analysis of armament programmes in a state about which little is known about the decision making structures, a third type of comparative analysis is added to the two previous ones (see note 16):

integration of the synchronic and diachronic approaches: this method enables the projection of a current armament programme in a developing country on to the history line of an industrialized state. Intersection occurs at some point on that history line. It represents the earlier stage of development of the industrialized state matching that of the developing country today. The comparison pertains to the material base of these countries and thus highlights some major material difficulties the developing country would encounter when pursuing a particular capability. This third method lies at the heart of proliferation research.

22 See, for example, the inability of International Court of Justice to formulate an opinion regarding the legality of the use of nuclear weapons if the survival of the state is at stake (see note 10).

23 A case in point is the so-called binary technology used in Iraqi and US chemical weapon designs in the 1980s. In the Iraqi case the binary approach was an expression of the inability to solve the stabilization of the agent for storage, so that the final precursors were only mixed moments before the chemical weapon was to be released over the target. Tractors with the chemical munitions on trailers were seen to drive around airfields to stimulate the chemical reaction inside the bombs. In contrast, the US binary shell and bomb involved high technology: the final precursors would be mixed inside the weapon during its trajectory toward the target. They were arguably the most 'democratic' weapons ever designed, because the promoters of the armament programme sought to depoliticize the binary chemical munitions on different levels (see note 15).

24 Such a massive technology transfer from civilian to military application preceded the launch of the first large-scale gas attack by German troops in April 1915. Zanders, J. P., 'The proliferation of biological weapons: a threat assessment', *Disarmament Forum*, no. 4 (2000), p. 15.

25 For more detailed discussion, see BioWeapons Prevention Project (note 3), pp. 91–101.

26 Zanders, J. P., 'Assessing the Risk of Chemical and Biological Weapons Proliferation to Terrorists', *Nonproliferation Review*, vol. 6, no. 4 (Fall 1999), pp. 17–34; Zanders, J. P., Karlsson, E., Melin, L., Näslund, E., and Thaning, L., 'Risk assessment of terrorism with chemical and biological weapons', *SIPRI Yearbook 2000: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2000), pp. 537–559; and Zanders, J. P., 'Weapons of mass disruption', *SIPRI Yearbook 2003: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2003), pp. 683–690.

27 For instance, the prime reasons for using CBW on the battlefield are not necessarily casualty production. Terrain denial, degradation of combat effectiveness by forcing the enemy to don protective clothing, degradation of the operability of facilities and equipment together with the imposition of the need for elaborate decontamination procedures, the causing of terror and psychological exhaustion, flushing out enemy troops from strongholds, incapacitation, crop destruction, and so on, are all major applications. Military commanders would have a range of agents with different characteristics (such as persistency) available to meet those objectives.

28 Carus, W. S., 'Bioterrorism and Biocrimes: The Illicit Use of Biological Agents in the 20th Century', Working Paper, Center for Counterproliferation Research, National Defense University, Washington, DC, August 1998 (March 1999 Revision), pp. 57–66. Carter, L. F., *Charisma and Control in Rajneeshpuram: the Role of Shared Values in the Creation of A Community* (Cambridge University Press: Cambridge, 1990), pp. 201–27. Török, T. J., Tauxe, R. V., Wise, R. P., et al, 'A large community outbreak of Salmonellosis caused by intentional contamination of restaurant salad bars', *Journal of the American Medical Association*, vol. 278, no. 5 (Aug. 1997), pp. 389–95.

29 The references to Aum Shinrikyo in this section are based on the analysis by Kaplan, D. E. and Marshall, A., *The Cult at the End of the World* (Arrow Books: London, 1996).

30 As an illustration of its ambition, Aum Shinrikyo had in addition to the chemical factory two buildings for biological research at its Mount Fuji headquarters. In Nagonohara it had a nearly finished biological plant. It made several unsuccessful attempts to spray botulinum toxin and anthrax from rooftops and trucks. Aum members also travelled to Zaire, apparently trying to obtain the Ebola virus. There is reportedly also some evidence that Aum Shinrikyo was producing Q fever. WuDunn, S., Miller, J. and Broad, W. J., 'How Japan germ terror alerted world', *New York Times*, 26 May 1998.

31 See note 16.

32 Chalk, 'The evolving dynamic of terrorism in the 1990s,' *Australian Journal of International Affairs*, vol. 53, no. 2 (1999), pp. 157–58.

33 Zanders, J. P., 'Chemical Weapons Proliferation: Mechanisms Behind the Imhausen/Rabta Affair', *Vredesonderzoek*, no. 4 (Interfacultair Overlegorgaan voor Vredesonderzoek, Vrije Universiteit Brussel: Brussels, March 1990), 64p.

34 Zanders, J. P., 'Chemical Weapons Between Disarmament and Non-proliferation', *The Monitor*, vol. 3, no. 3, (summer 1997), pp. 18-23.

35 Government–Industry Conference Against Chemical Weapons, 'Summary Statement by the Chairman, Senator The Hon Gareth Evans QC, Minister of Foreign Affairs and Trade of Australia' (GICCW Secretariat, Department of Foreign Affairs and Trade: Canberra, 22 September 1989), p. 2, §4.

36 Australia Group statement, 4 June 1992.

37 Anthony, I. and Zanders, J. P., ‘Multilateral Security-Related Export Controls’, *SIPRI Yearbook 1998: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1998), pp. 373-400.

38 With regard to CW, most direct transfers of munitions occurred during World War 1. Several allegations of chemical or biological warfare during the 1980s imply a direct transfer of CBW (mostly from the Soviet Union to allied governments or movements in Southeast Asia and Africa), but none of these allegations have actually been confirmed.

39 Mohamed ElBaradei, Director General of the International Atomic Energy Agency (IAEA), Statement To the Fifty-Ninth Regular Session of the United Nations General Assembly, New York, 1 November 2004, URL <http://www.iaea.org/NewsCenter/Statements/2004/ebsp2004n011.html>.

40 ‘Maintaining the Effectiveness of the Chemical Weapons Convention’, *SIPRI Policy Paper*, Stockholm, October 2002, p. 7, URL <http://www.sipri.org/contents/cbwarfare/Publications/pdfs/cwc_policypaper2.pdf>.

41 In contrast, certain chemical compounds have no other purpose than for chemical warfare. This single-use characteristic has been recognized by their inclusion in Schedule 1 of the CWC.

42 The phrase ‘other peaceful purposes’ is broad and potentially ambiguous. Particularly in the context of bio-defence programmes, certain activities—such as the open-air aerosolization of pathogens to study their dissemination patterns in order to improve detectors, or research into modified microbial agents in order to test the adequacy of existing medicines against them or to develop new ones—test the limits of what is considered legitimate under the BTWC. The results can also contribute to the preparations for offensive biological warfare.

43 Roffey, R., ‘Biological weapons and potential indicators of offensive biological weapon activities’, *SIPRI Yearbook 2004: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2004), p. 567.

44 Autio, E. and Laamanen, T. ‘Measurement and Evaluation of Technology Transfer: Review of Technology Transfer Mechanisms and Indicators’, *International Journal of Technology Management*, vol. 10, no. 7/8 (1995), 647.

45 Molas-Gallart, J., ‘Which way to go? Defence technology and the diversity of ‘dual-use’ technology transfer’, *Research Policy*, vol. 26 (1997), 369 and 371–72.

46 Molas-Gallart, J., ‘Dual-use technologies and the transfer mechanisms’, in Schroeer and Elena (eds.), note 16, p. 5

47 The concept can be illustrated with a simple example. A primary purpose of a carving knife (the technology) is to cut meat, but it is potentially a murder weapon (although this is not the manufacturer’s intent). If a person is cutting meat, then somebody else in the kitchen will not perceive the carving knife as a threat. If that same person is gesticulating a lot while holding the knife during a conversation, the second person will be concerned about risk of an accident. However, in the case of an angry exchange between the same two people the carving may become an attack weapon. Its dual-use potential as a murder weapon may be realized.

48 Molas-Gallart, J., ‘Which way to go? Defence technology and the diversity of ‘dual-use’ technology transfer’, *Research Policy*, vol. 26 (1997), p. 372, fn. 6.

49 See the discussion on page 14 and following.

50 One can also envisage that non-accredited economic units would be subject to a higher frequency of the other verification routines in the international agreement than accredited units in order to ascertain that no prohibited activities take place in them.

51 In the initial phases of implementing this model, a two-step approach could be envisaged whereby some economic units could receive provisional accreditation so that they have extra time for meeting the international standards without having to suffer the disadvantages from, for example, being located in a developing country.

52 It is noteworthy that an international industry organization like the International Organization for Standardization (ISO) has set up its own programme to assist developing countries in meeting the international standards. See the introduction to ISO at <http://www.iso.org/en/aboutiso/introduction/index.html>.

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