The dual-use dilemma in life science research: the approach of the International Committee of the Red Cross

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> *"Knowing is not a rationale for not acting. Can we doubt that knowledge has become a weapon we wield against ourselves?"*[2]
>
> Bill Joy, "Why the Future Doesn't Need Us", *Wired*

This paper is based on a presentation I was invited to deliver in November 2004 at the Amaldi Conference in Trieste about the International Committee of the Red Cross (ICRC)'s perspective on dual-use research in the life sciences. At first glance the ICRC might seem an unlikely actor to hold views on these complex issues as a humanitarian relief organization. But the ICRC has a responsibility to act in accordance with its mandate to protect and assist victims of conflict and to support and strengthen norms of international humanitarian law. These norms include taboos against poisoning and deliberate spreading of disease.

Accordingly, the paper sets out the ICRC's concerns about the potential for advances in the life sciences to be used for hostile purposes. I also canvas supporting arguments of my own: the increasing intangibility and diffusion throughout society of biotechnological and other related developments this century will mean that orthodox disarmament and arms

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[2] Bill Joy, « Why the Future Doesn't Need Us », *Wired*, (August 2001), available online at : http://www.wired.com/wired/archive/8.04/joy.html.

control processes are not sufficient on their own to stem these risks. The ICRC's 'web of prevention' approach, including actions following on from its appeal entitled *Biotechnology, Weapons and Humanity*, is one tool to deploy in conceptualizing and managing the so-called 'dual-use dilemma' in the life sciences.

State of Play

For many centuries poisoning and the deliberate spread of disease have been the subjects of public abhorrence. Diverse cultures, religions and military traditions proscribe them. Moreover, international rules including the 1925 Geneva Protocol, the 1972 Bacteriological and Toxin Weapons Convention (the BTWC, often referred to as the Biological Weapons Convention) and the 1993 Chemical Weapons Convention (CWC) formalize those prohibitions.[3]

Despite the existence of these norms, the perceived risk of a major biological weapons attack is increasing. While they caused relatively few casualties, anthrax mail attacks in the United States in late 2001 were extremely disruptive and costly to the US economy.[4] The culprit or culprits remain publicly unidentified. Moreover, there are growing worries within the Western scientific community that the twenty first century will see infectious disease, in particular, used as a weapon against civilian populations if society is not more vigilant. Scientific academies such as the Royal Society in the United Kingdom and the National Academies of Science in the United States have begun trying to advise their governments about responding appropriately to the potential for hostile use of their advances, especially concerning the possibility of 'bioterrorism'.[5] And, despite the failure to find evidence of biological weapons in Iraq, it nevertheless remains likely that clandestine government biological warfare programs continue in several countries in violation of international law.

At the same time, new developments in the life sciences, while exciting in a wide range of peaceful contexts, continue to increase the risk of use of biotechnological advances as, or for, weapons. These developments—in the fields of biology, chemistry, genomics, bioinformatics as well as many other disciplines—are leading to increased understanding of basic life processes such as metabolism, breathing, reproduction and cognition.[6] This greater understanding is accompanied by growing ability to manipulate these biological processes, for instance through genetic engineering. Information emanating from governments, United Nations agencies, scientific and medical circles and industry provides a disturbingly long list of existing and emerging capabilities for the misuse of such scientific advances.

The stark future humanity faces is that these new advances will make the development of biological weapons more attractive to those with hostile intent if the history of science

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[3] These treaties, as well as texts of many others, can be downloaded from the ICRC at : <http://www.icrc.org/ihl.nsf/WebFULL?OpenView>.

[4] Nevertheless, these attacks killed five people and made at least a dozen others gravely ill.

[5] See the Royal Society, Making the UK Safer: detecting and decontaminating chemical and biological agents, (Policy document 06/04), (April 2004) and The individual and collective roles scientists can play in strengthening international treaties (Policy document: 05/04), (April 2004) both available online at www. royalsoc.ac.uk. For the United States, the so-called «Fink Report » (after its Chair, Professor Gerald Fink) is a useful introduction: National Research Council of the National Academies, Biotechnology Research in an Age of Terrorism. (2004, Washington D.C., National Academies Press).

[6] A useful, and brief, introduction to these issues is by Mark Wheelis & Malcolm Dando, « New Technology and Future Developments in Biological Warfare », *Disarmament Forum,* (2000, vol. 4), (Geneva, United Nations), pp. 43-50.

and the past development of weapons are any guide.[7] And, it will make such hostile use potentially far more effective, while more difficult to detect. This means that beyond 'classical' bio-warfare agents such as anthrax, plague and smallpox, advances in legitimate science are broadening the possibilities for the creation and use of *new* hostile agents, with more varied characteristics and effects.[8] The leopard is increasingly able to change its spots.

In particular, two increasing trends in the life sciences are likely to make efforts to prevent new advances being misused for hostile purposes more complex. The first relates to growing understanding of biological structures as information. The discovery of DNA in 1953 by Watson, Crick and others brought with it the realization that genetic sequences are, at root, strings of information written in code. This formed the basis for the further development of molecular biology and related disciplines—including the ability to recombine information in genetic sequences to modify organisms and, ultimately, the ability to create genetic sequences. Although such synthesis is in its infancy, certain viruses have indeed recently been created synthetically without requiring an original sample using mail-order materials and a recipe from the Internet.[9] Bacteria may follow shortly.[10] The ease with which this information can be spread *virtually* will make traditional methods of regulation—for instance, physical controls on dangerous pathogens or permits for their transfer—less relevant if those pathogens can be created according to requirement using common equipment, materials and knowledge. Thus, the *intangibility* of advances in the life sciences is growing.

If this sounds far-fetched, then consider a well-established sector that has signally failed to anticipate the transformation of the availability of information from the tangible to the intangible, due to the wider spread of more advanced technologies within society. The large multi-national record companies are currently in crisis because overall demand has fallen for music purchased on compact discs, tapes and other physical (or tangible) formats. Instead, music is downloaded increasingly from the Internet in the form of compressed computer files—a situation to which the big music companies have been slow to adapt.[11] Although legal downloads of music, for which the consumer pays (and which usually contain built-in restrictions on copying and further distribution), are now increasingly common, peer-to-peer file-sharing networks including Napster (in its first iteration), Kazaa, BitTorrent and Limewire have provided the means for unauthorized and largely anonymous transfers of music, as well as many other forms of proprietary data file. Of course, bootlegging or pirating music is nothing new. But file sharing allows illicit

[7] A lot has been written on this subject. A useful and readable introduction is John Keegan, *A History of Warfare*, (London, Hutchinson, 1993). For an even broader view placing advances in technology and weaponry within the context of human development, are two almost peerless books by Jared Diamond, *Guns Germs and Steel : a Short History of Everybody for the Last 13,000 Years* (London, Vintage, 1997) and *The Rise and Fall of the Third Chimpanzee : How Our Animal Heritage Affects the Way We Live* (London, Vintage, 1991).

[8] An example was the inadvertent increase in lethality of mouse pox (an orthopox virus in the family of small pox) by Australian researchers through recombinant DNA splicing, and increasing research into synthetic construction of viruses, as first reported in the US journal *Science*. See Ronald J. Jackson, Alastair J. Ramsay, Carina D. Christensen, Sandra Beaton, Diana F. Hall, Ian A. Ramshaw, "Expression of Mouse Interleukin-4 by a Recombinant Ectromelia Virus Suppresses Cytolytic Lymphocyte Responses and Overcomes Genetic Resistance to Mousepox", *Journal of Virology*, (Vol. 75 No. 3) (February 2001), pp. 1205-1210.

[9] See Jeronimo Cello, Aniko V. Pail, Eckard Wimmer, "Chemical Synthesis of Poliovirus cDNA: Generation of Infectious Virus in the Absence of Natural Template", *Science*, (vol 297) (9 August 2002), pp. 1016-1018.

[10] See "The Journey of the Sorcerer", *The Economist: Technology Quarterly,* (4-10 December, 2004), pp. 27-28.

[11] For background, see « Music's Brighter Future », *The Economist Technology Quarterly*, (30 October-5 November 2004, pp. 79-81.

transfer of information files on a massive scale. As well as file sharing, the peer-to-peer (or P2P) model is now spreading to free Internet telephony (companies such as Skype, for example), with similarly profound potential implications for the economic and regulatory models on which the telecommunications industry is based.[12] How long before dangerous viral sequences are being swapped over the Internet? It is probably occurring already.

The example above also highlights the potential for *diffusion or democratization of technologies* within society that have 'dual-use' application in making biological weapons. The potential for physical—or tangible—proliferation will continue to exist and requires appropriate safeguards. But potential for the proliferation of digitally encoded, transmitted and duplicated complex information (like genetic sequences, or instructions for synthesizing viral or bacterial organisms) is escalating. This is the second trend referred to above. Such features have become apparent, for instance, where controls on intangible transfers of strong encryption for private use are concerned.[13]

These trends, deriving not only from technological invention in itself but from its wide-scale distribution and penetration of society, will require a change in thinking about traditional relationships between proliferation and prevention. Such fresh thinking is required because traditional approaches of government policymakers to regulate or stop proliferation of 'dual-use' or 'dual-capable' technologies are going to be increasingly ineffective on their own in the face of such changes.

Most of the international disarmament and arms control community's experience in non-proliferation and accompanying verification comes from experience in the nuclear and chemical fields. In these domains it is possible to verify 'stuff', whether fissile materials or chemicals. Plutonium, highly enriched uranium or a deadly toxin like ricin can be labelled, weighed and methods employed to figure how much of it there should be (or not be), for instance. Targets for verification are, moreover, comparatively easy to find because they tend to create a significant physical footprint: large physical facilities and other traceable infrastructure; a distinctive overall signature of activity. The physical signature for making biological weapons is significantly smaller and potentially much harder to detect.[14]

This does not mean detection is impossible. It means that different tools and assumptions are needed. This has been realized, for instance, by a group of independent scientific and industry experts in the United States "openly skeptical of the premature conclusion that the B[T]WC is unverifiable" who have sought to devise a plausible and effective system of compliance checks aimed at helping to prevent hostile use of the life sciences.[15]

Heterogeneous risks

International attention is currently focused primarily on the threat of biological attacks being perpetrated by terrorists ('bioterror') and, to a lesser degree lately, the continuing likelihood of state offensive biological warfare programmes. Despite this (and perhaps

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[12] See « In Praise of P2P », *The Economist : Technology Quarterly*, (4-10 December 2004), pp. 25-26.
[13] See Steven Levy, *Crypto : How the Code Rebels Beat the Government Saving Privacy in the Digital Age*, (New York, Viking Penguin, 2001).
[14] See Steve Tulliu & Thomas Schmalberger, *Coming to Terms With Security : a Lexicon for Arms Control, Disarmament and Confidence-Building*, (UNIDIR/2003/33) (Geneva, United Nations Institute for Disarmament Research (UNIDIR), 2003), particularly chapters 6 and 10.
[15] Center for Strategic and International Studies, *Resuscitating the Bioweapons Ban: U.S. Industry Experts' Plans for Treaty Monitoring : A Collaborative Research Report of Experts from the U.S. Pharmaceutical and Biotechnology Industries*, (Washington D.C., CSIS, November 2004), p. vii.

even stemming from this attention) there are also other avenues of hostile use of advances in the life sciences. Professor Malcolm Dando, a neurobiologist and arms control expert, has pointed out that the motives behind hostile use may be more complex than first meets the eye:

> "Beyond malice or unbridled curiosity, the "militarization of biology" may also be a siren song for many scientists, physicians and their employers simply in need of a livelihood. Because prohibited actions derive from intent, the line between legitimate defensive activities and banned offensive weapons development may not be easily visible."[16]

These complexities are sure to mount in the course of advances in the life sciences this century. Such advances will blur distinctions between offensive and defensive use.

The development of so-called 'non-lethal' chemical and biological agents in several countries—most prominently in the United States—is troubling in this regard.[17] The difficulties for troops fighting in urban warfare situations, combined with a track record of use of chemical agents such as 'tear' gas in certain law enforcement situations (which is legal), has resulted in research into the utility of developing biological or chemical agents for military for the purposes of incapacitation. This is sometimes rationalized on the basis that it would be more humane than the use of conventional 'lethal' weapons.[18]

But use of such agents as weapons is unambiguously banned by the BTWC and CWC. There is no threshold for lethality within the prohibitions of these treaties—nor should there be. This is because the lethality of a given weapon is denoted by context, not only by its technical characteristics. For instance, wounds inflicted by automatic rifles in battlefield situations tend to be lethal only a proportion of the time, subject to the specific context (available cover, location of the wound impact, the victim may be wearing body-armour, access to timely medical treatment etc). By contrast, the same weapon used in a firing squad situation will be lethal nearly one hundred percent of the time, for obvious reasons.

'Non-lethal' or 'less-lethal' are, in other words, marketing terms. Use of a fentanyl-derived opioid anaesthetic agent in 2002 by Russian Special Forces to lift the Moscow theatre siege amply and tragically demonstrated this principle when about 120 of the 700 hostages died of the effects of the gas. (All of the approximately 50 Chechen rebels died—shot dead while unconscious by Russian special forces personnel in order to prevent them triggering bombs strapped to their bodies in case they woke up.)[19]

Use of disabling, paralyzing or 'knock-out' agents in conflict situations also creates real difficulties for the application of humanitarian law, which recognizes only two types of person in a conflict—combatants and civilians. Civilians should not be attacked. And a

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[16] Professor Malcolm Dando (Department of Peace Studies, University of Bradford, United Kingdom), Statement to the Conference Commission on Biotechnology, Weapons and Humanity, 28th International Conference of the Red Cross and Red Crescent Movement, 4 December 2003. Available on the web at: <http://www.bradford.ac.uk/acad/nlw/research_reports/docs/BNLWRPResearchReportNo5_May04.pdf>

[17] For more information on the United States' 'non-lethal' weapons program see Neil Davison & Nick Lewer, *Bradford Non-Lethal Weapons Research Project (BNLWRP) Research Report No. 5*, (Bradford, University of Bradford Centre for Conflict Resolution/Department of Peace Studies, May 2004). This report is accessible online at :

[18] See Mark Wheelis, « « Non-Lethal » Chemical Weapons : A Faustian Bargain », *Issues in Science and Technology*, (Spring 2003), pp. 74-78. Despite the lack of reference to biological weapons in the title, in a related article Wheelis outlines the increasing lack of distinction in practice between new advances in biology and chemistry. See Mark Wheelis, « Biotechnology and Biochemical Weapons », *The Non-Proliferation Review*, (Spring 2002), pp. 48-53.

[19] See Robin Coupland, «Incapacitating Chemical Weapons : A Year after the Moscow Theatre Siege », *The Lancet*, (Vol. 362) (25 October 2003), p. 1346.

combatant is entitled to protection under humanitarian law if captured, wounded or having surrendered (that is, *hors de combat*).[20] Would troops deploying such agents in a chaotic combat situation demonstrate the diligence necessary to distinguish an adversary unwilling to surrender from a combatant made unconscious or paralyzed (and thus *hors de combat*), yet still with, or slumped over, a weapon? Recent instances of atrocities in Iraq in which wounded Arab fighters in a mosque in Fallujah in Iraq were shot by nervous American troops in late 2004 suggest that these dilemmas would be acute.

Moreover, despite the lure of new weapon technologies for offensive advantage, history shows us that these are almost always temporary: the adversary either adopts equivalent weapons and tactics, or develops an antidote weapon that restores the tactical balance. Sooner or later those militaries initially deploying such 'non-lethal' agents are likely find themselves facing the same types of weapon, or worse. The only rational line is the one that has been drawn: no poison or use of disease in war.

Although the BTWC bans biological weapons it does not contain measures to ensure confidence in compliance to deter or catch cheaters. This has long been recognized as a weakness in the treaty: by the mid-1990s international efforts were underway to remedy this by devising a verification regime. Those efforts were curtailed in July 2001 by the United States' rejection of a proposed final text and any continued negotiations on the draft protocol. Without the further prospect of American participation the protocol negotiations collapsed—a situation American negotiators exploited in pushing (successfully) for much less ambitious deliberative 'expert' discussions.[21]

Agreement in late 2002 on these deliberative discussions in the context of the BTWC resulted in a sequence of annual meetings of experts each summer followed by a more procedural meeting of representatives of BTWC States Parties each December, until 2006. Although these gatherings are no substitute for negotiations on a legally binding instrument to strengthen the Convention's prohibitions through compliance and enforcement, they nevertheless have allowed some trust to be regained among countries participating after the difficulties of the protocol negotiation's breakdown. And, they have focused some attention on governments on discussion topics including national implementing legislation for the BTWC, for instance adequate criminal penalties, the physical security of dangerous pathogens, improving disease surveillance and response capabilities and mechanisms to investigate potentially deliberate outbreaks of disease. The 2005 discussions, which will be chaired by Ambassador John Freeman of the United Kingdom, will focus on codes of conduct for those working in the life sciences. This is an

[20] See the International Committe of the Red Cross, *Summary of the Geneva Conventions of August 12, 1949 and their Additional Protocols*, (Geneva, ICRC, 2001), p.2 : « Persons not directly taking part in hostilities and those put out of action through sickness, injury, captivity or any other cause must be respected and protected against the effects of war ; those who suffer must be aided and cared for without discrimination. The Additional Protocols extend this protection to any person affected by an armed conflict. They furthermore stipulate that the parties to the conflict and the combatants shall not attack the civilian population and civilian objects and shall conduct their military operations in conformity with the recognized rules and belaws of humanity. »

[21] Documents from these meetings are available at <http://www.opbw.org>. The following December, at the Fifth BTWC Review Conference, Under-Secretary of State for Arms Control John Bolton made it clear that the US administration saw the draft protocol as an example of « arms control approaches of the past », which « will not resolve our current problems .» For useful evaluations of the post-Fifth Review Conference 'Expert process' in the BTWC see Jonathan B. Tucker & Raymond A. Zilinskas, « Assessing U.S. Proposals to Strengthen the Biological Weapons Convention » in *Arms Control Today* (April 2002), pp. 10-14 and Nicholas A. Sims, « Biological Disarmament Diplomacy in the Doldrums : Reflections After the BWC Fifth Review Conference », *Disarmament Diplomacy*, (no. 70) (April-May 2003) at <http://www.acronym.org.uk>.

issue of particular interest to bodies such as the Royal Society in the United Kingdom and to the ICRC, for reasons explained below.

The ICRC appeal

Although usually known for its work in the field to assist and protect the victims of armed conflict, the ICRC also has a mandate to endeavour to prevent suffering by promoting and strengthening humanitarian law and universal humanitarian principles. Prompted by these concerns described above, ICRC issued a public appeal in September 2002 entitled *Biotechnology, Weapons and Humanity*.[22]

Launching a public appeal is rare for the ICRC and underlines the importance it attaches to maintaining the fundamental norms against poison and deliberate spreading of disease. However, it was not entirely unprecedented. The ICRC launched a related public appeal in 1918, in which it described warfare by poison as "a barbaric invention which science is bringing to perfection..." and protested "with all the force at [its] command against such warfare, which can only be called criminal"[23]. The 1918 appeal is still valid today. Responding in part to that appeal, States adopted the 1925 Geneva Protocol reaffirming the general ban on the use of poisonous and asphyxiating gases in warfare and extended it to cover bacteriological (that is, biological) weapons.

The ICRC appeal on *Biotechnology, Weapons and Humanity* is aimed at governments, industry, academic researchers, health professionals and scientific circles, as well as civil society in general. It is intended to promote the implementation of practical measures to prevent the use of the life sciences for hostile purposes, both by individual actors and in improving synergy between them.

The 'web of prevention'

The ICRC describes this approach as the 'web of prevention'. Development of this concept stemmed from the ICRC's realization, in response to a large number of consultations with individual and institutional actors in the professional life sciences, that there is a very low general level of awareness in that community about the prohibitions against biological and chemical weapons. This is worrying because these scientists, physicians, policymakers and related business people have particular responsibilities to uphold taboos against poisoning and deliberate use of disease because they are the primary agents of these advances.

The 'web of prevention' concept developed by the ICRC is intended to help relate these legal and ethical norms to individuals and institutions in the life sciences by properly informing them of the *risks*, *rules* and *responsibilities* associated with preventing hostile use of their advances. This knowledge should help to motivate them to objectively assess and reduce risk in this sphere, and to take action accordingly.

Such engagement requires three main phases of action from actors in the life sciences:

1. To acknowledge that minimizing risks from the hostile use of advances in the life sciences is of concern to them and part of their responsibility.

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[22] For a full text of the ICRC appeal on *Biotechnology, Weapons and Humanity* see the ICRC website, which also contains other resources and links on this subject, at www.scienceforhumanity.org.

[23] Bulletin international des Sociétés de la Croix-Rouge, CICR, Genève, April 1918.

2. To identify and implement the necessary actions within their own sphere of influence that will contribute to risk reduction and that complement actions being taken in other spheres; and
3. Ensure their actions are known amongst and complement the actions of others.

Examples of practical measures in the life sciences that can contribute to a 'web of prevention' include:

- Scrutinizing all research with potentially dangerous consequences and submitting it to rigorous and independent peer review.
- Adopting professional and industrial codes of conduct aimed at preventing the abuse of biological agents.
- Ensuring effective regulation of research programmes, facilities and biological agents that could lend themselves to misuse, and supervising individuals with access to sensitive technologies.
- Supporting enhanced national and international programmes to prevent and respond to the spread of infectious disease.
- Ensuring that awareness of the risks, rules and responsibilities associated with preventing poisoning and deliberate spreading of disease are part of laboratory or other training for all personnel.

This is only an indicative list. Depending on the context, many other practical measures may be applicable. Such individual preventive actions may not result in major changes by themselves. But they can add up to be very effective in combination and do not have to be complex, expensive or onerous in reflecting the particular circumstances of a situation. The benchmark is that they should be effective in the context to which they are applied.

It is important to note that the ICRC is not trying to tell actors in the life sciences *how* they should implement their responsibilities into practical action. Rather, it is to remind them that ethical and legal obligations exist and that they should be implemented thoughtfully.

One analogy relevant to understanding the 'web of prevention' model in the life sciences is that of fire prevention. The use of fire is relevant to many aspects of our everyday lives, whether we are conscious of it or not. At the same time, fire can be highly dangerous if used improperly, for example for arson. No one proposes banning fire. However, there is virtually universal awareness of the potential risks and of the need for practical measures to minimize improper use of fire and its consequences.

Fire-trucks and firefighters arriving to extinguish a fire are dramatic and highly visible elements of society's efforts to minimize its risk and harmful effects. But most of the time a combination of mundane and largely un-noticed complementary measures such as smoke detectors, safe building construction codes, properly marked fire exits, safety evacuation drills, extinguishers and sprinkler systems reduce fire risk effectively. Moreover, as well as reducing the risk of an outbreak, such practical measures may minimize the effects of a dangerous fire if it occurs. Most fire-prevention measures are not dramatic, and rarely interfere with legitimate daily business. They are there, nevertheless. So it should be with the life sciences, which—like the use of fire—carry impacts for society through their benefits and risks.

What the ICRC is doing

The ICRC has been involved in a range of activities with actors in the life sciences around the world since the launch of its appeal. In line with its 'web of prevention' approach the ICRC is not only approaching governmental officials but also representatives from biotech and pharmaceutical companies, governmental laboratories and other agencies, academia, scientific and medical associations.

On 7 May 2004 the ICRC convened a one-day roundtable in London in partnership with the British Red Cross. This meeting, entitled '*On preventing hostile use of the life sciences'*, engaged representatives of the British-based life science community from all of the groups mentioned above. The aim of the meeting was to gather together a wide range of these actors in order to engage on the issues raised in the ICRC appeal and, in particular, to promote their greater cooperation and coordination in achieving its aims.

Over the coming months, further roundtables are planned at national and regional levels around the world in order to continue engaging representatives from the professional life science community on these issues. Similar to the first roundtable, the discussion themes will focus on:

1. How to promote and disseminate awareness of international legal norms relevant to preventing hostile use of the life sciences at the individual and institutional level.
2. Means of educating scientists about risks, rules and responsibilities and the creation of a culture of responsibility and enhancing complementary and co-ordinated action.
3. Practical measures that individuals and institutions could implement in their own environments to reduce risk of misuse of their materials and technologies.

The ICRC has also contributed, by invitation, to other gatherings of actors in the life sciences around the world on themes related to reducing the risk of hostile use of their advances. These meetings, including the 2004 Trieste Amaldi Conference, have offered the ICRC the opportunity to engage with various professional life science communities on the concerns in its appeal.

In addition, the ICRC has developed promotional material, including posters specifically intended to catch attention of scientists working in laboratories, in order to help raise awareness within the scientific and industrial communities.[24] Moreover, the ICRC will also publish guiding principles and action points for life science professionals on the common international humanitarian norms formalized in different bodies of law about poisoning and deliberate spread of disease shortly (check the ICRC's website for further details).

These principles and action points are not intended to impose yet more regulation on legitimate science. They should instead provide a suggested checklist to include in discussions on, for example, research, research proposals, funding, publication, contracts of employment for scientists, health and safety procedures, professional practice, peer-review processes and educational programmes. They should also contribute to discussions in the framework of the 2005 Meeting of Experts of the BTWC, which will address and

[24] The posters can be downloaded in electronic format at: <http://www.gva.icrc.org/Web/eng/siteeng0.nsf/html/pS200402?OpenDocument>, 27 September 2004.

promote common understanding and effective action on "the content, promulgation, and adoption of codes of conduct for scientists."[25]

Moreover, the ICRC invited States to consider the drafting and adoption of a ministerial-level declaration in addition to its outreach to the professional life science community in early 2004. This would be intended to reaffirm the relevance and continued importance of the norms against poisoning and the deliberate spread of disease—something that the international community failed to include, for the first time in December 2002, in a BTWC Review Conference Final Document. High-level commitment reflected in a ministerial declaration would also draw greater attention to these issues at a senior political level and send a clear signal to scientists and industry that their governments consider preventing hostile use of their materials, expertise and equipment to be imperative.

The way forward

The comment by Bill Joy, a software architect and one of the co-founders of Sun Microsystems, that "knowledge is a weapon we wield against ourselves" at the beginning of this paper is highly pertinent to the 'dual use dilemma' in the life sciences. Indeed, it was specifically written with an eye to them from the point-of-view of a technological and industrial insider, which is what makes its candour remarkable. Advances in the life sciences may become increasingly subtle and desirable—yet deadly—weapons, if misused. And that route to hostile use from intent is becoming a more accessible one. In view of this, the industrial, scientific and biomedical communities need to face up to the risks, rules and responsibilities associated with their work thoughtfully. It is not enough for the task of preventing hostile use of advances in the life sciences to effectively be outsourced to governments through diplomatic processes like the BTWC. Like Joy has done, there needs to be more contemplation of the roles individuals and institutions can play in alleviating or contributing to the awful risks of poisoning or deliberately spreading disease and practical action in response.

It is also going to require framing these issues in the context of other pressing security and social priorities while nevertheless considering the potential humanitarian effects of the use of new advances for biological weapons soberly. Viewing issues of poisoning or deliberate infectious disease through law enforcement or national security ('bioterror') lenses are necessary components of an effective response. But they do not comprise it. As Gerald Epstein noted, "policy measures to impede biological weapons development can generate serious tensions between the research community, industry, and the national security community."[26] There is need, therefore, for broader dialogue between these communities in order to arrive at common understandings in view of their different objectives, cultures and norms. This is not without precedent in the biological community, as the Asilomar Conference in the United States demonstrated in February 1975, at which scientific leaders from around the world agreed to a voluntary moratorium on certain kinds of research activity and to institute enhanced physical security and containment measures for other categories of research.

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[25] See the Final Report of the Fifth Review Conference of The States Parties To The Convention On The Prohibition Of The Development, Production And Stockpiling Of Bacteriological (Biological) And Toxin Weapons And On Their Destruction (Geneva, 19 November–7 December 2001 and 11–22 November 2002) (BWC/CONF.V/17), p. 4.

[26] Gerard L. Epstein, « Controlling Biological Warfare Threats : Resolving Potential Tensions among the Research Community, Industry, and the National Security Community », *Critical Reviews in Microbiology*, (Vol 27 No 4) (2001), pp. 321-354, p. 321.

There should be broader recognition that bio-security is a component of bio-safety – not the other way around. In most cases the risk of hostile use of the life sciences is likely to be low, although it should never be regarded as insignificant in view of its potential for deadly consequences. Moreover, resources are usually scarce. For this reason, the best 'bang for buck' is probably for prevention of hostile use of the life sciences to be viewed predominantly as an element of public health awareness, response and capacity building. It is also important to recognize that conflicts of interest can exist that result in the promotion of measures generating enormous profit, prestige and power for those engaged in them, but which may not reflect the most rational setting of priorities balancing the risks against benefits in prevention and preparedness.[27]

With that caveat in mind, if vigilance nevertheless fails then the increasing potency of advances in the life sciences could lead to deleterious humanitarian consequences on a massive scale if they are deployed as biological weapons. This is the basis for the ICRC's concerns and for its efforts in the field of greater awareness and prevention of hostile use of the life sciences. A multi-layered risk assessment and reduction approach depending on awareness and action at the individual and institutional levels ('bottom up') as well as governmental ('top down') levels is what is needed in a wide range of areas in science, commerce and medicine. This is encapsulated in an easily understandable way in the ICRC *web of prevention* concept, in order to promote reflection and action. It means making industry, scientific and medical communities and other relevant actors partners in the process of prevention, rather than merely the objects of policy or regulation by central authorities. Such mutual engagement needs to be ongoing as science and technology advance and, commensurately, the risks evolve.

[27] See Victor W. Sidel, :Bioterrorism in the United States : a Balanced Assessment of Risk and Response », *Medicine, Conflict and Survival*, (vol. 19, 2003), pp. 318-325.