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Abstract

The underlying thesis of this Article is that while smaller-sized particles and separate nano-sized carriers of known agents are clearly covered by the CWC, nanomimics are not as squarely within the relevant provisions. The bulk of this Article deals with that question. Despite the invitation to woolgather, this Article is limited to the tightest possible analytical approach. Part I begins with definitions of chemical and biological agents within existing treaties, and of nanoproducts, including those existing beyond presently-known technical capabilities, but which are at least reasonably conceivable ("nanobots"). Part II provides an overview of treaty law that is potentially applicable to nanobots. It first examines current treaties that are facially applicable to nanoproducts. Because of the possibility that the "all analogous . . . devices" language of the 1925 Geneva Protocol bans nanobots, the Article examines very closely the origin, application, and meaning of that language. A close inspection necessarily involves considerable discussion of pre-1914 treaties, as well as the battles, weapons, tactics, and legal analyses in World War I, and the mass reaction to them, which resulted in a series of treaties implicating chemical weapons after the war ended. Part II then looks briefly at other treaties, conventions, and doctrines of international law that may impact the use of nanobots. Part III briefly examines current theories regarding good faith treaty interpretation and their implications for the utilization of antique (but not necessarily antiquated) doctrines and documents to interpret current law. Part IV then applies the current treaties to nanoproducts, both existing and potential, in light of the preceding discussion, and then turns to a discussion of whether a new treaty, or modifications or clarifications to existing treaties, are advisable.

A TINY PROBLEM WITH HUGE IMPLICATIONS—NANOTECH AGENTS AS ENABLERS OR SUBSTITUTES FOR BANNED CHEMICAL WEAPONS: IS A NEW TREATY NEEDED?

Evan J. Wallach[*]

"[T]he Law of Nations . . . allows not the taking the Life of an Enemy, by Poison; which Custom was established for a general Benefit, lest Dangers should be increased too much. . . . Humanity, and the Interests of [the] Parties, equally require it; since Wars are so frequent and . . . the Mind of Man, ingenious in inventing Means to do hurt . . . ."
—Hugo Grotius[1]

INTRODUCTION

In 2005, the U.S. Army's Environmental Policy Institute ("AEPI") posed a scenario and a question. The AEPI offered this provocative picture of future combat:

> Consider this scenario: A column of soldiers moves through the close confines of a city. Because of the potential for hostilities, the soldiers are maintaining a MOPP[2] level 2

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1. 3 HUGO GROTIUS, THE RIGHTS OF WAR AND PEACE 567, 567 n.XV(1) (Jean Barbeyrac ed., Lawbook Exchange, Ltd. 2004) (1625).

2. Mission-oriented protective posture, or "MOPP" as it is commonly referred, is a military acronym that is used to specify different levels of protective gear that personnel wear in toxic environments. *See* U.S. ARMY, THE WARRIOR ETHOS AND SOLDIER COMBAT SKILLS 13-10, § 13-26, Field Manual No. 3-21.75(FM21-75) (Jan. 28, 2008), *available at*

> posture and chemical detectors are deployed in the column. Suddenly from the surrounding rooftops, there are gunshots and a number of canisters are hurled off the roof tops. Within moments, portions of the column are enveloped in hazy cloud and within a minute or so the soldiers closest to the canisters are twitching and salivating uncontrollably and even those soldiers who were able to don their protective masks and gloves are showing the same symptoms. Soldiers from the rear of the column move forward having easily cleared the roof tops with automatic weapons fire in an effort to aid their comrades. Although the chemical agent detectors show no evidence of conventional chemical agents, they administer nerve agent antidotes in accordance with their training, but the victims worsen and quickly die. Within a few minutes, even the fully garbed soldiers find themselves salivating beyond control and trembling. Soon, they too are dead; the chemical agent detectors remain silent.
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> What happened here is but one possible result of nanotechnology harnessed to do the will of terrorists. Traditional chemical agents are largely prohibited by treaty or agreement and the precursors of traditional agents can be tracked. As nanotechnology advances, it will be possible to design materials that act like chemical agents, in this case a cholinesterase blocking agent, but *are not classed as chemical agents under any existing protocol*, do not trigger existing chemical agent detectors and in any case do not respond to known nerve agent antidotes and, because of their small size, can penetrate protective fabrics and even mask filters.[3]

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https://rdl.train.army.mil/soldierPortal/atia/adlsc/view/public/24572-1/fm/3-21.75/fm3_21x75.pdf. The MOPP system designates four levels of increasing protection that are designed to be commensurate with the environmental risk. For a graphical representation of the different levels, see U.S. AIR FORCE, MISSION-ORIENTED PROTECTIVE POSTURES (MOPP), No. AFVA32-4012 (Feb. 1, 1998), *available at* http://www.fas.org/nuke/guide/usa/doctrine/usaf/32401200.pdf.

3. JOHN P. MCGUINNESS, ARMY ENVTL. POLICY INSTIT., NANOTECHNOLOGY: THE NEXT INDUSTRIAL REVOLUTION—MILITARY AND SOCIETAL IMPLICATIONS 20 (2005), *available at* http://www.aepi.army.mil/internet/nanotech-industrial-revolution.pdf (emphasis added). The United States Army's Environmental Policy Institute's ("AEPI") assumption here appears to be that the nanomaterials used in the scenario are something other than the chemical agents and their precursors listed in the Chemical Weapons Convention ("CWC"). *See* discussion *infra* Part I. Rather, they "act like" chemical agents. The AEPI seems to be describing only one potential type of nanoweapon—a device which mimics the effects of chemicals on the human body by means other than a direct chemical reaction. These devices are what the AEPI calls "nanomachines" in its recommendations section. *See id.* at 27.

In short, the AEPI posited that nanomaterials which mimic banned chemical agents ("nanomimics")[4] might be developed and used in combat. The Institute recommended that someone should determine "if nanomachines are chemical weapons under the provisions of the Chemical Weapons Convention."[5] This Article attempts to do exactly that.[6] The results are interesting and, in most instances, very clear. Existing treaties certainly cover both nanoparticles of banned chemical weapon materials and

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4. This Article uses the word "nanomimic" to refer to devices that causes the same result as a banned poison, toxin or other chemical substance. In biology, mimicry occurs when one species imitates another. *See* WOLFGANG WICKLER, MIMICRY IN PLANTS AND ANIMALS 8 (R.D. Martin trans., 1968). Batesian mimicry,

> is thought to occur when a rare harmless species evolves to resemble closely an abundant noxious model. It gains protection from its predators which cannot tell the difference between model and mimic, and since they tend to encounter models rather than mimics when searching for food, they associate the colour pattern of the model with the nasty experience, and tend to avoid it in future.

FRANCIS GILBERT, THE EVOLUTION OF IMPERFECT MIMICRY IN HOVERFLIES 1 (2004), *available at* http://eprints.nottingham.ac.uk/96/1/ImperfectMimicry.pdf. Hoverflies that resemble bees or wasps are an example. *See id.* at 4–5. In Mullerian mimicry, "several noxious species evolve to resemble each other, and hence all benefit by a reduction in predation." *Id.* at 1.

5. MCGUINNESS, *supra* note 3, at 27.

6. In a broad sense, the question was raised even earlier by a professor of engineering at West Point:

> The importance of ethics and professional responsibility in engineering design cannot be overemphasized when weapons of mass destruction can be inexpensively and straightforwardly created by anyone with modest specialized knowledge and equipment. Arms control style agreements offer one option for halting the spread of dangerous technology applications, but these agreements will not include non-state terrorist and radical militant groups. However, arms control treaties would still be important tools to restrain the dark side of emerging technologies, and the Army could provide the prime forces for verification of compliance with international treaties and agreements. In the case of non-state sponsored militant groups, the Army could find itself a major Homeland Defense Force team member, working closely with intelligence organizations to enforce United Nations sanctioned ethical standards and controls on research into unmistakably dangerous technologies; including infectious biotechnology products, malicious information technology viruses, and other nefarious weapons.

Col. Kip Nygren, *Emerging Technologies and the Army*, AMPTIAC Q., Spring 2002, at 15. As described by the U.S. government, "[t]he Advanced Materials, Manufacturing, and Testing Information Analysis Center (AMMTIAC) is the [U.S. Department of Defense's] Center of Excellence responsible for acquiring, archiving, analyzing, synthesizing, and disseminating scientific and technical information related to advanced materials, manufacturing, and testing." Advanced Materials, Manufacturing, and Testing Information Analysis Center, http://ammtiac.alionscience.com/about/ (last visited Apr. 3, 2010).

nano-sized devices designed to carry such particles.[7] Because, however, answers regarding potential development of nanomimics are not entirely clear,[8] the recommendation of this Article is that states parties[9] may wish to amend the 1993 Chemical Weapons Convention ("CWC")[10] to clearly cover as yet undeveloped nanomachines.[11]

Nanotechnology is a relatively new field of knowledge studying and applying the development and application of very small particles of matter.[12] While it has implications across a wide range of science including chemistry, physics, and biology,[13] it is

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7. As will be discussed below, chemical carriers will certainly be duel use; they are currently being publicly developed and deployed for medical treatment, particularly in oncology. *See infra* Part I.C.

8. Although, as this Article demonstrates, a legal argument for noncoverage of nanomimics by existing treaties requires an interpretation of the law at least at the edge of bad faith.

9. This Article is directed to whether states are bound under international law, and whether certain conduct by them might constitute war crimes. Several of the scenarios and discussions cited mention the possibility of using chemical weapons by terrorists. This Article does not deal directly with actions by terrorists, but since, in any definition, terrorists are nonstate actors, and generally commit what would be war crimes if committed by a state, the analysis is perfectly applicable, albeit in a multistep fashion. *See, e.g.*, International Convention for the Suppression of the Financing of Terrorism, Dec. 9, 1999, S. TREATY DOC. NO. 106-49 (2000), 2178 U.N.T.S. 229; International Convention for the Suppression of Terrorist Bombings, Dec. 15, 1997, S. TREATY DOC. NO. 106-6 (1999), 2149 U.N.T.S. 256; Convention for the Prevention and Punishment of Terrorism, Nov. 16, 1937, 19 L.N.O.J. 23; Declaration on Measures to Eliminate International Terrorism, G.A. Res. 49/60, Annex, U.N. Doc. A/RES/49/60 (Feb. 17, 1995), *supplemented by* Declaration to Supplement the 1994 Declaration on Measures to Eliminate International Terrorism, G.A. Res. 51/210, Annex, U.N. Doc. A/RES/51/210 (Dec. 17, 1996).

10. Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction, *opened for signature* Jan. 13, 1993, S. TREATY DOC. NO. 103-21 (1993), 1974 U.N.T.S. 45 [hereinafter Chemical Weapons Convention].

11. *See generally* Ralf Trapp, *Advances in Science and Technology and the Chemical Weapons Convention*, ARMS CONTROL TODAY, Mar. 2008 (raising, inter alia, the possible need for convention modifications). As to whether nanomachines are feasible, see *infra* Part I.A.

12. *See generally* J. CLARENCE DAVIES, WOODROW WILSON INT'L CTR. FOR SCHOLARS, OVERSIGHT OF NEXT GENERATION NANOTECHNOLOGY (2009), *available at* http://207.58.186.238/process/assets/files/7316/pen-18.pdf.

13. Except for the implications of nanobots, which as will be seen below, might involve some living parts, this Article does not extensively examine the separate biological aspects of nanotechnology and its interplay with the Biological Weapons Convention of 1972. *See* Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, Apr. 10, 1972, 26 U.S.T. 583, 1015 U.N.T.S. 163 [hereinafter Biological

widely regarded as crossing many of the traditional scientific boundaries of those fields of study.[14] Nanotechnology is of particular interest to students of law and warfare[15] in three respects: First, nanoparticles of known chemical warfare agents or precursors to those agents may have different effects on protective gear and on human physiology than conventionally sized particles of those agents.[16] Second, nano-sized carriers, similar to those currently under development for chemotherapy,[17] may deliver target doses of chemical agents to targeted cells in the human body.[18] Third, speculative[19] literature predicts that the eventual production of robots on the nanoscale will be possible some day.[20] In effect, these nanoscale robots would enter the human body, penetrate cells, and cause them to act in a fashion similar to the effects of currently banned chemical weapons.[21]

The underlying thesis of this Article is that while smaller-sized particles and separate nano-sized carriers of known agents are clearly covered by the CWC, nanomimics are not as squarely within the relevant provisions. The bulk of this Article deals with that question. In light of that analysis, however, it is important to

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Weapons Convention]. The analysis, while analogous, has other implications simply outside the scope of this Article. Additional research in the field might prove fruitful for further study.

14. DAVIES, *supra* note 12, at 16.

15. There are, of course, numerous other regulatory interests including, inter alia, environment, health, safety, and trade. *See generally* JENNIFER PELLEY & MARC SANER, REGULATORY GOVERNANCE INITIATIVE, CARLETON UNIV., INTERNATIONAL APPROACHES TO THE REGULATORY GOVERNANCE OF NANOTECHNOLOGY (2009), *available at* http://www.carleton.ca/regulation/publications/Nanotechnology_Regulation_Paper_April2009.pdf.

16. MCGUINNESS, *supra* note 3, at 20.

17. *See* discussion *infra* Part I.C.

18. *See infra* notes 80–81 and accompanying text.

19. Many reputable scientists reject such speculation as purely "science fiction." *See infra* note 89 and accompanying text. This Article addresses the issue both because the U.S. Army has raised the question, and because history has shown that humanity's destructive impulses are often the most fruitful for the progress of scientific knowledge. Note particularly the discussion below of speculation and arguments about the possibility of new chemical and biological weapons before the adoption of treaties in the 1920s. Many of the most pessimistic scientific speculations at the time proved true. *See* discussion *infra* Part II.A.

20. *See generally* Daniel Harris, *Will Robots Come To Our Medical Rescue?*, ELECTRONIC DESIGN, Aug. 16, 2007, at 28 (discussing how nanorobots can enter the human body to provide medical care).

21. *See id.*

recognize that the CWC incorporates the 1925 Geneva Gas Protocol,[22] which prohibits, in part, that "the use in war of asphyxiating, poisonous or other gases, and of *all analogous* liquids, materials or *devices*."[23] An extremely strong argument can therefore be made that the CWC facially bans nanomimics. That argument, however, depends on the intention of the states signatory to the treaties.[24] In determining the intention of a party, recourse may be had to the drafting history and working papers, contemporaneous general commentary by the legal community and the press, the events of the recent history before the treaty was signed, and, of course, signing statements and reservations.[25] Some of that material is, however, mixed, contradictory, vague, lost, or was intentionally omitted in original

22. Chemical Weapons Convention, *supra* note 10, pmbl, art. XIII. The Biological Weapons Convention ("BWC") incorporates the 1925 Geneva Protocol as well. Biological Weapons Convention, *supra* note 13, pmbl., art. XVIII. Interestingly, the U.S. Senate ratified both the BWC and the Geneva Protocol on the same day, December 16, 1974. *See* S. EXEC. REP. NO. 93-35 (1974); S. EXEC. REP. NO. 93-36 (1974). At the signing ceremony on January 22, 1975, President Gerald Ford described the ratification as "completing a process which began almost 50 years ago when the United States proposed at Geneva a ban on the use in war of 'asphyxiating, poisonous or other gases'" and stated that "the United States has long supported the principles and objectives of the Geneva Protocol." Gerald Ford, U.S. President, Geneva Statement on the Protocol of 1925 and Biological Weapons Convention, 72 DEP'T ST. BULL. 567 (1975).

23. Protocol for the Prohibition of the Use in War of Asphyxiating Poisonous or Other Gases, and of Bacteriological Methods of Warfare, June 17, 1925, 26 U.S.T. 571, 94 L.N.T.S. 65 [hereinafter Geneva Protocol] (emphasis added). The BWC generally covers both poisons and toxins. Poison in its common usage refers to "any substance that, when *relatively small amounts* are ingested, inhaled, or absorbed, or applied to, injected into, or developed within the body, *has chemical action* that causes damage to structure or disturbance of function, producing symptoms, illness, or death." W.B. SAUNDERS, DORLAND'S ILLUSTRATED MEDICAL DICTIONARY 1502 (31st ed. 2007) (emphasis added). A toxin, on the other hand, is defined as "a poison, frequently used to refer specifically to a protein produced by some higher plants, certain animals, and pathogenic bacteria, which is highly toxic for other living organisms. Such substances are differentiated from the simple chemical poisons and the vegetable alkaloids by their high molecular weight and antigenicity." *Id.* at 1968.

24. *See* Vienna Convention on the Law of Treaties art. 31, May 23, 1969, 115 U.N.T.S. 331 [hereinafter Vienna Convention]; *see also, e.g.*, Factor v. Laubenheimer, 290 U.S. 276, 293 (1933) ("Considerations which should govern the diplomatic relations between nations, and the good faith of treaties, as well, require that their obligations should be liberally construed so as to effect the apparent intention of the parties to secure equality and reciprocity between them.").

25. *See* Vienna Convention, *supra* note 24, art. 32.

publications.[26] It is, in short, a law professor's nirvana, for it leaves room for endless analytical speculation.

Despite the invitation to woolgather, this Article is limited to the tightest possible analytical approach. Part I begins with definitions of chemical and biological agents within existing treaties, and of nanoproducts, including those existing beyond presently-known technical capabilities, but which are at least reasonably conceivable ("nanobots").[27] Part II provides an overview of treaty law that is potentially applicable to nanobots. It first examines current treaties that are facially applicable to nanoproducts. Because of the possibility that the "all analogous

26. For example, in his introductory comments at the 1922 Naval Conference former U.S. Secretary of State Elihu Root stated that the language introduced by the U.S. delegation was borrowed from the Treaty of Versailles, which ended World War I between most of the Allies and Germany. *See* Edwin James, *Hughes Proposes Gas Ban*, N.Y. TIMES, Jan. 7, 1922, at 1. In fact, the U.S. proposal did substantially track the language of the Treaty of Versailles, but it also differed in respects vital to this analysis from the other treaties ending the Great War with Austria, Hungry, Bulgaria, and Turkey. *See* RAYMOND L. BUELL, THE WASHINGTON CONFERENCE 207–09 (1922). Was Root intentionally misleading the conferees, did he honestly miss the distinctions, or did he recognize them, but think they were so unimportant as to not be worth mentioning? All those questions have a bearing on the analysis in this article and on future applications of the treaty banning chemical weapons on the 21st Century. *See* discussion *infra* Part II.A.1.d.ii.

27. It has been suggested that the term "nanobots" is inherently misleading, and that a more accurate phrase is "enhanced nanomaterials." Another suggestion was that, for the purposes of this Article, "nanobots" are indistinguishable from specifically engineered viruses. The Author disagrees that the term "nanobots" has no utility, but acknowledges that clearly it is fraught with discord. One problem in the area is that there are some assumptions based on prior speculation, initially envisioned by Kim Eric Drexler, about what is essentially self-replication of nano-sized machines. *See* K. ERIC DREXLER, ENGINES OF CREATION: THE COMING ERA OF NANOTECHNOLOGY 53–63 (1987). The dispute is fascinating, and beyond the Author's capacity as a layman in the field of nanotechnologyto evaluate, but it is largely irrelevant to the question posed by the AEPI that is answered here. "Nanobot" for purposes of this Article is a device on the nanoscale which is capable of mimicking the effect of chemical nerve agents, *see* discussion *infra* Part I.A.4, but is neither a product of chemical processes, nor a biological agent as banned by the BWC. *See* discussion *infra* Part IV.A.3. This Article will therefore not address other pertinent critiques of the term, particularly those related to Brownian motion (movement of particles suspended in fluid), and the numbers of individual devices which might be necessary to constitute a lethal dose. It bears note, however, that the speculation in this Article is largely based on assumptions emerging from medical research, particularly in the field of cancer research. *See* discussion *infra* Part I.C. In any case, when one deals with potential weapons development it is always wise to err on the side of expecting the worst, for "[t]here are more things in heaven and earth, Horatio, than are dreamt of in your philosophy." WILLIAM SHAKESPEARE, HAMLET, act 1, sc. 5.

. . . devices" language of the 1925 Geneva Protocol[28] bans nanobots, the Article examines very closely the origin, application, and meaning of that language. A close inspection necessarily involves considerable discussion of pre-1914 treaties, as well as the battles, weapons, tactics, and legal analyses in World War I, and the mass reaction to them, which resulted in a series of treaties implicating chemical weapons after the war ended. Part II then looks briefly at other treaties, conventions, and doctrines of international law that may impact the use of nanobots. Part III briefly examines current theories regarding good faith treaty interpretation and their implications for the utilization of antique (but not necessarily antiquated) doctrines and documents to interpret current law. Part IV then applies the current treaties to nanoproducts, both existing and potential, in light of the preceding discussion, and then turns to a discussion of whether a new treaty, or modifications or clarifications to existing treaties, are advisable.

I. *CURRENT DEFINITIONS OF CHEMICAL AGENTS, BIOLOGICAL AGENTS, AND NANOSYSTEMS*

The most modern sources of law controlling the acquisition and use of chemical and biological weapons are the 1972 Biological Weapons Convention ("BWC")[29] and the 1993 CWC.[30] Given past experiences, the drafters of the more recent conventions relating to biological and chemical weapons were specific in their coverage.[31] Accordingly, current law quite explicitly bans "[m]icrobial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes" and "[w]eapons, equipment or means of delivery designed to use such agents or toxins for

28. *See* Geneva Protocol, *supra* note 23 and accompanying text.

29. *See* Biological Weapons Convention, *supra* note 13.

30. *See* Chemical Weapons Convention, *supra* note 10.

31. As will be discussed below, the history of arms control treaties is often also a history of their evasion.Often, that evasion was justified by what the evading party characterized as distinguishing factors of the weapon that it used. *See, e.g.*, *infra* Part II.A.1.c (discussing Germany's use of chlorine gas in 1915).

hostile purposes or in armed conflict."[32] It is also unequivocal in its prohibition of *all* chemical weapons.[33]

It is particularly important to note that the CWC covers any "chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals . . . regardless of their origin or of their method of production."[34] Accordingly, a broad class of current or immediately potential nanoproducts may be covered by the

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32. Biological Weapons Convention, *supra* note 13, art. I(1)–(2).

33. *See* Chemical Weapons Convention, *supra* note 10, art. I. The CWC contains a very specific definition of "chemical weapons":

> (a) Toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes;
>
> (b) Munitions and devices, specifically designed to cause death or other harm through the toxic properties of those toxic chemicals specified in subparagraph (a), which would be released as a result of the employment of such munitions and devices;
>
> (c) Any equipment specifically designed for use directly in connection with the employment of munitions and devices specified in subparagraph (b).

Id. art. II(1). "Toxic chemicals" are defined with a similar level of specificity:

> Any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals. This includes all such chemicals, regardless of their origin or of their method of production, and regardless of whether they are produced in facilities, in munitions or elsewhere.

Id. art. II(2). The CWC is written broadly enough to cover existing and undiscovered applications and substances. The continuing work of the Organization for the Prohibition of Chemical Weapons demonstrates that this level of breadth was intended by the drafters. *See* discussion *infra* Part IV.A.3.b; *see also* S. TREATY DOC. NO. 103-21, at 8 (1993) ("The intention of this broad definition [of chemicals] is to prohibit all known and unknown, and future toxic chemicals in types and quantities that cannot be justified for permitted purposes"). *But cf.* Robert Pinson, *Is Nanotechnology Prohibited By the Biological and Chemical Weapons Conventions?*, 22 BERKELEY J. INT'L L. 279, 294 (2004) (arguing that it may be possible to use nanotechnology for conventional weapon purposes under the broad exceptions permitted by the CWC).

34. Chemical Weapons Convention, *supra* note 10, art. II(2). The CWC's definition of chemical weapons differs from the way other international agreements define weapons. Typically, "a weapon is usually considered to be the entirety of its components, and characterized by certain more or less objective criteria . . . that would allow for distinction between those types of weapons covered by the treaty and those not covered . . . ." WALTER KRUTZSCH & RALF TRAPP, A COMMENTARY ON THE CHEMICAL WEAPONS CONVENTION 23 (1994). Under the CWC, by contrast," each of the components of a chemical weapons system in itself *already has to be regarded as the prohibited weapon.*" *Id.* at 24 (emphasis added); *see also* WALTER KRUTZSCH AND RALF TRAPP, VERIFICATION PRACTICE UNDER THE CHEMICAL WEAPONS CONVENTION (1999) (commenting on the verification provisions under the CWC).

CWC; others might not. To comprehend potential applications one must first understand the language of nanotechnology.[35]

A. *Nanotechnology and Molecular Nanotechnology*

Nanotechnology is, broadly put, the science of the very small. In *Military Nanotechnology*, Jurgen Altmann states that nanotechnology, including nanoscience, "is about investigating as well as manipulating matter on the atomic and molecular level. At this level, the borders between the disciplines physics, chemistry, [and] biology vanish, including their sub-, intermediate and applied fields, such as materials science, mechanics, electronics, biochemistry, genetics, [and] neurology."[36] A useful discussion of general concepts is found in *Nanotechnology and Homeland Security*:

> [Nanotechnology] is the application of nanoscience to useful devices. Nanoscience . . . is the science that deals with objects with at least one dimension between one and one hundred nanometers in length, a size range called the nanoscale. A nanometer is one one-billionth of a meter . . . . [W]hy does [nanoscience] get so much hype, and why is it so important for national defense and national security? The first reason is that nanoscale objects . . . are a special kind of small. Individual atoms are around one-fifth of a nanometer. The size of almost all molecules . . . lies within the nanoscale, because it is the smallest level within which functional matter can exist . . . . This means that . . . we can make materials whose amazing properties can be defined in absolute terms [and] it is the scale at which the quirky quantum mechanical properties of matter and its more familiar mechanical properties (such as hardness, temperature and melting point) meet. At the nanoscale it is possible to take advantage of both sets of properties . . . .[37]

35. Some useful terminology may be found in Classification Order 1850. Patent & Trademark Office, U.S. Dep't of Commerce, Classification Order 1850 (2005), *available at* http://www.uspto.gov/web/offices/opc/documents/1850.pdf (providing search criteria for nanotechnology patent research).

36. JÜRGEN ALTMANN, MILITARY NANOTECHNOLOGY, POTENTIAL APPLICATIONS AND PREVENTIVE ARMS CONTROL 1 (2006).

37. DANIEL RATNER & MARK A. RATNER, NANOTECHNOLOGY AND HOMELAND: NEW WEAPONS FOR NEW WARS SECURITY 13–14 (2004).

Certainly, there is a great deal of current military interest in nanotechnology[38] and an equal amount of excitement, if not money, in the medical realm.[39] Indeed, medical research has overlapping applicability of considerable interest:

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38. Nanotech research projects are being conducted at, inter alia, the Massachusetts Institute of Technology's Institute for Soldier Nanotechnologies, the U.S. Army's Future Force Warrior program, the UK's Future Infantry Soldier Technology project, Germany's Projekthaus System Soldat, and Italy's Soldato Futuro initiative. *See The March of Technology*, ECONOMIST, June 10, 2006, at 30 (discussing each of these programs); *see, e.g.*, DIR., DEF. RESEARCH AND ENG'G, U.S. DEP'T OF DEF., DEFENSE NANOTECHNOLOGY RESEARCH AND DEVELOPMENT PROGRAM 3 (2007), *available at* http://www.nano.gov/html/res/DefenseNano2005.pdf (explaining that the objective of defense nanotechnology programs is "[t]o discover and exploit unique phenomena at these dimensions to enable novel applications enhancing war fighter and battle systems capabilities."); JUN WANG & PETER J. DORTMANS, DEP'T OF DEFENCE, A REVIEW OF SELECTED NANOTECHNOLOGY TOPICS AND THEIR POTENTIAL MILITARY APPLICATIONS 22 (2004) (Austl.), *available at* http://www.dsto.defence.gov.au/publications/2610/DSTO-TN-0537.pdf (noting "the concept of nanobots needs to advance beyond the drawing board before being considered within feasible technology concepts."); Lothar Ibrugger, North Atlantic Treaty Organization, *The Security Implications of Nanotechnology*, 179 STCMT 05 E, (2005) (discussing military applications of nanotechnology); Chapelle Brown, *Nanotech Goes to War*, EE TIMES, Aug. 25, 2003, http://www.eetimes.com/story/OEG20030825S0017 (providing an overview of the Massachusett Institute of Technology's Institute for Soldier Nanotechnologies); Barnaby J. Feder, *Frontier of Military Technology Is the Size of a Molecule*, N.Y. TIMES, Apr. 8, 2003, at C2 (quoting from U.S. Deputy Under Secretary of Defense with the Office of Basic Research at the Defense Department that "[n]anotechnology will eventually alter warfare more than the invention of gunpowder"); David Hambling, *Nanotechnology Goes to War,* GUARDIAN (London), Mar. 5, 2009, at 6 (considering military applications of nanotechnology warfare); Stefan Nitschke, *Nanotechnology: Applications for Naval Warfare*, 26 NAVAL FORCES 36 (2005) (same).

39. *See, e.g.*, Robert Austin & Shuang-fang Lim, *The Sackler Colloquium on Promises and Perils in Nanotechnology for Medicine*, 105 PROC. NAT'L ACAD. SCI. U.S. 17217, 17218 (2008) (contemplating the potential application of nanotechnology in medicine); Adriano Cavalcanti et al., *Medical Nanorobotics for Diabetes Control*, *in* 4 NANOMEDICINE: NANOTECHNOLOGY, BIOLOGY, AND MEDICINE 127, 127–35 (2008) (same, with respect to diabetes); Adriano Cavalcanti et al., *Nanorobot Hardware Architecture for Medical Defense*, 8 SENSORS 2932, 2947 (2008) (proposing mass embedded nanorobots with chemical sensors for early epidemiological detection, and which apparently does not consider the potential public reaction to perceived government intrusion); James R. Heath et al., *Nanomedicine Targets Cancer*, 300 SCI. AM., 44, 44–51 (2009) (reviewing the mechanics of nanoscale cancer monitoring systems); Tom C. Thomas & Rachelle Acuna-Narvaez, *The Convergence of Biotechnology and Nanotechnology: Why Here, Why Now?,* 12 J. COM. BIOTECHNOLOGY 105, 105–08, (2006) ("[N]anomaterials and devices can be built at the same size as cell components, making them ideal for interacting with individual molecules."). Additionally, nanomaterials and devices are ideal for as well as the chemical delivery value of tree branched nanomaterials called "dendrimers." Thomas & Acuna-Narvaez, *supra*, at 108; *see also* Giorgia Guerra, *A Model for Regulation of Medical Nanobiotechnology: The European Status Quo,* 3 NANOTECHNOLOGY. L. & BUS. 84 (2006)

> Nanoscale devices and nanoscale components of larger devices are of the same size as biological entities. They are smaller than human cells (10,000 to 20,000 nanometers in diameter) and organelles and similar in size to large biological macromolecules such as enzymes and receptors—hemoglobin, for example, is approximately 5 nanometers in diameter . . . . *Nanoscale devices smaller than 50 nanometers can easily enter most cells*, while those smaller than 20 nanometers can transit out of blood vessels, offering the possibility that nanoscale devices will be able to penetrate biological barriers such as the blood—brain barrier . . . [a]nd because of their size, *nanoscale devices can readily interact with biomolecules on both the cell surface and within the cell* . . . .[40]

Why does this medical research matter in warfare?[41] A basic understanding of some concepts of physiology, chemistry, biochemistry, and history is important to fully appreciate its relevance.[42] An underlying concern of those who fear use of

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(pointing out the difficulty of classifying nanotechnology within the current legal regulatory hierarchy of the European Union).

40. NAT'L CANCER INSTIT., U.S. DEP'T OF HEALTH AND HUMAN SERV., CANCER NANOTECHNOLOGY PLAN: A STRATEGIC INITIATIVE TO TRANSFORM CLINICAL ONCOLOGY AND BASIC RESEARCH THROUGH THE DIRECTED APPLICATION OF NANOTECHNOLOGY 25 (2004) (emphasis added), *available at* http://ntc-ccne.org/documents/cancer_nanotechnology_plan.pdf.

41. *See* Andy Oppenheimer, *Nanotechnology Paves Way for New Weapons*, JANE'S CHEM-BIO WEB, July 27, 2005, http://www.hartford-hwp.com/archives/27a/317.html ("As with many technologies, the medical applications may be adapted for offensive purposes. Manipulation of biological and chemical agents using nanotechnologies could result in entirely new threats that might be harder to detect and counter than existing [chemical and biological weapons]. New agents may remove previous operational difficulties of biological warfare, such as effective delivery of the agent. The large surface area of nanoparticles, relative to their overall size, increases their toxicity when inhaled. Advanced capabilities may include the use of genetic markers to target specific organs in the body, or an ethnic group, or even a specific individual . . . . The design of new agents that attack specific body organs such as the central nervous system would enable far smaller amounts of the chemical to be made without detection and would require only small, low-level facilities.").

42. In 1914, a British scientist, Henry Dale, described the physiological effects of a substance called acetylcholine. In 1921, Otto Loewi, an Austrian scientist, provided the first proof that acetylcholine transmitted messages from one nerve cell to another, and from those cells to organs such as the heart. Loewi later demonstrated acetylcholine is broken down by an enzyme called cholinesterase. JONATHAN B. TUCKER, WAR OF NERVES CHEMICAL WARFARE FROM WORLD WAR I TO AL-QAEDA 52 (2006). In essence,

> [t]he arrival of a nerve impulse at the junction between a nerve and a muscle cell induces the release from the nerve ending of molecules of acetylcholine, which diffuse across a narrow gap called the synapse and stimulate receptors on the surface of the muscle cell, triggering a series of biochemical events that

nanobots in warfare, often not explained except with references to nerve agents,[43] is that the bots will enter or otherwise affect nerve cells, and will act as cholinesterase inhibitors,[44] but in a *physical* rather than a *chemical* manner.[45] The results would be the same, but would they be covered by the CWC?

> cause the muscle fibers to contract. Under normal conditions, cholinesterase enzymes in the synapse immediately break down the acetylcholine and halt the stimulation of the receptors, allowing the muscle fibers to relax. . . . [Nerve gases] inhibit[] the action of cholinesterase . . . [thus freezing] the biochemical on-off circuit in the 'open' position, allowing [toxic acetylcholine build-up]. Because acetylcholine plays multiple roles in the peripheral, autonomic, and central nervous systems, excessive amounts give rise to diverse physiological effects [including violent, uncontrollable spasms of skeletal muscles followed by paralysis, excessive salivation, vomiting, bronchial constriction, and seizures]. Nerve agents can induce death by asphyxiation through three different mechanisms: constriction of the bronchial tubes, suppression of the respiratory center of the brain, and paralysis of the breathing muscles.

Id. 52–54. This excellent work is extremely useful for anyone seeking to understand the history of the development and deployment of nerve gases.

43. *See* Glenn Harlan Reynolds, *Environmental Regulation of Nanotechnology: Some Preliminary Observations*, [2001] 31 Envtl. Law Rep. (Envtl. Law Inst.) 10681, 10684 ("Nanotechnological devices for military use also raise the issue that they do the work of chemical and biological weapons, but—at least arguably—do not fall within the treaties regulating chemical and biological weapons. The argument that nanotechnological weapons—at least those of destructive, rather than surveillance, type—would be functional equivalents of chemical and biological weapons would be a strong one, and indeed *destructive nanoweapons would probably achieve their effects through chemical action, though it would be mechanically initiated*." (emphasis added)).

44. Fed'n of Am. Scientists, Introduction to Chemical Weapons, http://www.fas.org/programs/ssp/bio/chemweapons/introduction.html (last visited Apr. 3, 2010) ("Nerve gases are liquids, not gases, which block an enzyme (acetylcholinesterase) that is necessary for functions of the central nervous system."); *see also* discussion *infra*, Part II.A.1.d.iv.

45. *See* U.S. CONG., OFFICE OF TECH. ASSESSMENT, TECHNOLOGIES UNDERLYING WEAPONS OF MASS DESTRUCTION, USGPO No. OTA-BP-ISC-115, at 23–24 (1993), *available at* http://www.au.af.mil/au/awc/awcgate/ota/9344.pdf ("Two classes of nerve agents, designated G and V agents, were produced . . . by the United States and the former Soviet Union. The G-series nerve agents are known both by informal names and military code- names: tabun (GA), sarin (GB), GC, soman (GD), GE, and GF. This class of compounds was discovered in 1936 by Gerhard Schrader of the German firm IG Farben during research on new pesticides . . . . All the various G agents act rapidly and produce casualties through by inhalation, although they also penetrate the skin or eyes at high doses . . . . The V- series nerve agents include VE, VM, and VX, although only VX was weaponized by the United States. These agents were originally discovered in 1948 by British scientists engaged in research on new pesticides . . . . VX is an oily liquid that may persist for weeks or longer in the environment. Although not volatile enough to pose a major inhalation hazard, [V-series agents are] readily absorbedableable through the skin. The lethal dose of VX on bare skin is about 10 milligrams for a 70 kilogram man.").

Despite considerable institutional skepticism,[46] there has been at least some discussion of nanorobot concepts which appears to be based in hard fact and science,[47] and capable of being utilized by nonexperts to examine reality.[48] In *Bio-Nanorobotics: State of the Art and Future Challenges*, the authors focus on molecular machines either naturally occurring, or created "from scratch" synthetically but "using nature's components."[49] They note that "[t]he main goal in the field of molecular machines is to use various biological elements—whose function at the cellular level creates motion, force or a signal—as machine components."[50] The authors suggest that:

> So far, there does not exist any particular guideline or a prescribed manner, which details the methodology of designing a bio-nanorobot. There are many complexities, which are associated with using biocomponents (such as protein folding and presence of aqueous medium), but the advantages of using these are also quite considerable. These biocomponents offer immense variety and functionality at a scale where creating a man-made material with such capabilities would be extremely difficult. These

46. *See* Rudy Baum, *Nanotechnology: Drexler and Smalley Make the Case For and Against 'Molecular Assemblers,'* CHEMICAL & ENGINEERING NEWS, Dec. 1, 2003, at 37 (documenting the well-publicized debate regarding the feasibility of nanotecology between Smalley and Drexler); Mikael Johansson, *"Plenty of Room at the Bottom": Towards an Anthropology of Nanoscience*, ANTHROPOLOGY TODAY, Dec., 2003, at 3–6 (providing excellent examples of scientific skepticism of Drexler's nano-concepts); Richard E. Smalley, *Of Chemistry, Love and Nanobots*, SCIENTIFIC AM., Sept. 2001, at 76–77 (arguing that certain types of nanorobots are not feasible); Rudy Baum, *Nanotechnology: Drexler and Smalley Make the Case for and Against "Molecular Assemblers"*, 81 CHEMICAL & ENGINEERING NEWS, Dec. 1, 2003, at 37–42; *cf.* K. Eric Drexler & Jason Wejnert, *Nanotechnology and Policy*, 45 JURIMETRICS J. 1, 8 (2004) ("A more serious issue is the prospect of losing the arms race in developing this technology. The United States presently has an informal but effective nanotechnology in place that, if continued, will guarantee loss in the arms race.").

47. *Are Nanobots On Their Way?*, NANOTECHNOLOGY WKLY., May 12, 2008, at 1 ("The first real steps towards building a microscopic device that can construct nano machines have been taken by U.S. researchers.").

48. *See* Daubert v. Merrell Dow Pharmaceuticals, 509 U.S. 579, 589–92 (1993) (discussing expert testimony standards about scientific knowledge that may assist the trier of fact); *cf.* Lesley Wexler, *Limiting the Precautionary Principle: Weapons Regulation in the Face of Scientific Uncertainty*, 39 U.C. DAVIS L. REV. 459, 524–25 (2006) (arguing in favor of scientific knowledge standard similar to that mentioned in *Daubert*).

49. *See* Ajay Ummat et al., *Bio-Nanorobotics: The State of the Art, and Future Challenges*, *in* TISSUE ENGINEERING AND ARTIFICIAL ORGANS 19-1, 19-2 (Joseph D. Bronzino ed., 3d ed. 2006).

50. *Id.*

> biocomponents have been perfected by nature through millions of years of evolution and hence . . . very accurate and efficient.[51]

The authors go on to suggest that a "library of bio-nanocomponents" will be developed including categories such as actuation, energy source, and signaling, enabling design and development of bio-nanosystems with "enhanced mobile characteristics" and the ability to "transport themselves as well as other objects to desired locations at the nano scale."[52] The authors contemplate this discussion in the context of medical repair,[53] but the applications to future warfare appear equally possible,[54] and they raise fascinating questions. As Shipbaugh notes, "[f]uturistic applications are highly speculative and a main source of contention in scientific debates over nanotechnology. It is not necessary to dwell upon replicating molecular systems to

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51. *Id.* at 19-19.

52. *Id.* at 19-21.

53. The authors' discussion appears realistic. They conclude that problems like protein folding, precise mechanisms of molecular motors, and swarming behavior are unsolved. *Id.* at 19-33. Still, they assert:

> The future of bio-nanorobots . . . is bright. We are at the dawn of a new era in which many disciplines will merge including robotics, mechanical, chemical and biomedical engineering, chemistry, biology, physics, and mathematics so that fully functional systems will be developed. However, challenges towards such a goal abound. Developing a complete database of different biomolecular machine components and the ability to interface or assemble different machine components are some of the challenges to be faced in the near future.

Id.

54. It bears mention that the beginning of a new scientific epoch is always fraught both with possibilities and dead ends. One is reminded of the era between the Wright brothers' announcement of manned powered heavier-than-air flight in December, 1903, and the myriad approaches of the next half dozen years. *See* Today in History: December 17, First Flight, http://memory.loc.gov/ammem/today/dec17.html (last visited Apr. 3, 2010) (**"**The announcement of the Wright brothers' successful flight ignited the world's passion for flying. Engineers designed their own flying machines, people of all ages wanted to witness the flights, and others wanted to sit behind the controls and fly."). Scientists, futurists, quacks, cranks, and the suicidal adventurous explored not only wing-warping versus elevators and ailerons, but also shapes mimicking nature, ornithopters, flying bicycles, and any number of other startling advances and lethal dead-ends. Some of them led to the modern air craft we now take for granted. *See* Movies and Photos, Photographs of the Invention of the Airplane, http://invention.psychology.msstate.edu/moviesandphotos/rogues.html (last visited Apr. 3, 2010) (containing photographs of such aircrafts); *see also* Posting by Miss Cellania to mental_floss blog, http://www.mentalfloss.com/blogs/ (Aug. 14, 2007, 04:46 EST) (reviewing attempts at aviation prior to the Wright brothers' landmark flight).

realize that nanotechnology applications can become very provocative."[55]

Indeed, the U.S. Army has considered the implications for some time, at least in the area of biological weapons. In 1999, Lonnie Henley raised the possibility of several novel biological warfare applications[56] including, "subject to prevailing law and arms treaties," selective agents that can distinguish friend from foe, triggered agents that harm only in specific situations "[n]ew ways to kill or incapacitate opponents," "[p]enetration aids" to bypass defenses or immunities, or "[a]nti-material agents."[57] Henley did not consider the chemical warfare implications, per se.

Legal implications of nanotechnology in the unconventional weapons context, have been raised before.[58] Many of the discussions have been narrowly directed to a particular regulatory approach,[59] are downright utopian,[60] or are relatively limited in their content.[61]

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55. Calvin Shipbaugh, *Offense-Defense Aspects of Nanotechnologies: A Forecast of Potential Military Applications*, 34 J.L. MED. & ETHICS 741, 746 (2006).

56. Henley included the the caveat that,

> [i]t is easy to get carried away with such speculation. Even with rapid progress in all the necessary fields, it will be at least decades before we can mass-produce microscopic machinery tailored to our purposes. There is no reason to doubt that it is feasible in the long run, however, and some militarily useful products could be available in 20 years or so.

Lonnie D. Henley, *The RMA After Next*, PARAMETERS, Winter 1999–2000, at 46.

57. *Id.*

58. *See* Gary E. Marchant & Douglas J. Sylvester, *Transnational Models for Regulation of Nanotechnology*, 34 J.L. MED. & ETHICS 714, 719 (2006) ("Notwithstanding some science fiction scenarios, it is highly unlikely that current or near-term applications of nanotechnology would rise to the level of potential weapons of mass destruction. In the longer term, it is possible that some [could,] but such possibilities are likely far into the future and governments are unlikely to act to try and to prevent such scenarios through international agreements until such risks are more concrete and defined."). *See generally* Pinson, *supra* note 33. The legal implications of nanotechnology have been raised in other areas as well. *See* Michael Van Lente, *Building the New World of Nanotechnology*, 38 CASE W. RES. J. INT'L L. 173, 178–83 (2006) (listing extensive investments in nanotechnology on a global scale); Albert Lin, *Size Matters: Regulating Nanotechnology*, 31 HARV. ENVTL. L. REV. 349, 351 (2007) ("Of more immediate concern [than nanobots] are the potential risks posed by nanoscale science and engineering."); James Yeagle, *Nanotechnology and the FDA,* 12 VA. J.L. & TECH. 6 (2007) (advocating for greater federal study in the area of nanotechnology in order to create a regulatory regime).

59. *See, e.g.*, Gregory Mandel, *Nanotechnology Governance*, 59 ALA. L. REV. 1323 (2008) (providing several suggestions on how to improve the regulation of nanotechnologuy); Kenneth W. Abbott et al., *A Framework Convention for Nanotechnology?*, [2008] 38 Envtl. L. Rep. (Envtl. Law Inst.) 10,507, 10,507–08 (discussing four general

Glenn Reynolds, however, directly addresses aspects of a number of important questions including that of bio-nanorobotics. In *Nanotechnology and Regulatory Policy*, Reynolds notes that, "these nanodevices would not suffer from the constraints facing living organisms—they would not have to be

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principles for nanotechnology regulation, though not specifically weapons-related); Lynn L. Bergeson, *Regulation, Governance and Nanotechnology: Is a Framework Convention for Nanotechnology the Way to Go?*, [2008] 38 Envtl. L. Rep. (Envtl. Law Inst.) 10,515, 10,515–17 (discussing approaches towards regulating nanotechnology, generally); David Rejeski, *Comment on A Framework Convention for Nanotechnology?*, [2008] 38 Envtl. L. Rep. (Envtl. Law Inst.) 10,518, 10,518–19 (same); *see also, e.g.*, Brent Blackwelder, *Comment on a Framework Convention for Nanotechnology?*, [2008] 38 Envtl. L. Rep. (Envtl. Law Inst.) 10,520 (arguing that the need for a regulatory regime is so dire that a moratorium should be placed on nanotechnology worldwide until one is created); Sean Howard, *Nanotechnology and Mass Destruction: The Need for an Inner Space Treaty*, DISARMAMENT DIPLOMACY, July–Aug. 2002, at 3 (calling for an "inner space treaty" to guard against the use of nanotechnology as a weapon of mass destruction).

Glenn Reynolds raises several problems with the prohibitionist approach mentioned by several authors. *See* Glenn Harlan Reynolds, *Nanotechnology and Regulatory Policy: Three Phases*, 17 HARV. J. L & TECH. 179, 191 (2003). Not only would it impact potentially useful scientific advances, but nanotechnology research facilities are relatively easy to hide from a prohibitionist inspection regime. *Id.*; *see also*, Wexler, *supra* note 48, at 515 (suggesting the amendment of article 36 of the 1977 Protocol I to the 1949 Geneva Convention).

While the protocols may, in some aspects, represent articulations of current customary law, the United States is not currently a signatory to the protocols. *Cf.* Vladimir Murashov & John Howard, *The US Must Help Set International Standards for Nanotechnology*, NATURE NANOTECH., Nov. 2008, at 635 (2008) (advocating implementation of international standards for nanotechnology); Joel Rothstein Wolfson, *Social and Ethical Issues in Nanotechnology: Lessons From Biotechnology and Other High Technologies*, [Aug. 2003] 22 Biotech. L. Rep. (Mary Anne Leibert, Inc.) 376, 381 ("The dangers of nanotechnology as a terrorist weapon are easy to see. First, a nano-robot that can operate within a human body could easily be programmed to destroy rather than heal.").

60. *See, e.g.*, Lindsay V. Dennis, Note, *Nanotechnology: Unique Science Requires Unique Solutions*, 25 TEMP. ENVTL. L. & TECH. J. 87, 111–13 (2006) (proposing the creation of an "Emerging Technologies Department" by U.S. Congress to provide "centralized regulation" of nanotechnology which would be independent of executive and congressional oversight).

61. *See* Juan P. Pardo-Guerra & Francisco Aguayo, *Nanotechnology and the International Regime on Chemical and Biological Weapons*, 2 NANOTECHNOLOGY L. & BUS. 55 (2005) (painting in very broad strokes the issues involved). Some analysis may be found in Jason Wejnert, *Regulatory Mechanisms for Molecular Nanotechnology*, 44 JURIMETRICS J. 323 (2004). While Wejnert's paper focuses on preventing the "'release' into the wild" of molecular nanotechnology products, it mentions both the possible development of a unique molecular nanotechnology treaty, and of something modeled around the Nuclear Non-Proliferation Treaty. *Id.* at 329 He also discusses the potential application of both the Biological Weapons Convention and Chemical Weapons Convention. *Id.* at 331–36. However, Wejnert's paper posits enforcement problems, and does not address the current applicability issues raised in this paper. *Id.* at 349.

made of protein or other substances readily extractable from the natural environment, nor would they have to be capable of reproducing themselves."[62] It is interesting to compare this statement with Ummat, Sharma, Mavroidis, and Dubey's discussion of bio-nanobots.[63] Key questions arise about treaty coverage depending on whether these bots are, in fact, bugs, for they may, depending on attributes of life,[64] fall within the BWC, the CWC, or in the cracks between.

Reynolds also notes that "[t]he same technology that could selectively destroy cancer cells could instead target immune or nerve cells, producing death or further debility."[65] Others have raised similar issues:

> [N]ano-bots may in the future travel through the blood stream seeking and killing off cancer cells, or may assist with the regeneration of healthy cells. At the opposite extreme, it may also be possible to use nano-bots for military purposes to detect motion in a field and transmit signals many miles away, or to achieve "programmable" genocide. Drexler's vision is that such robots, known as "assemblers," will have the ability to self-replicate . . . and [be able] to work in unison to build macro-scale devices en masse. While commentators such as Whiteside and Smalley have dismissed these ideas as futuristic hype, nanotechnology nevertheless captures one exciting conceptual possibility.[66]

The Stockholm International Peace Research Institute has expressed some concern in this area as well:

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62. Reynolds, *supra* note 59, at 185 (citing K. ERIC DREXLER, ENGINES OF CREATION, 56-63 (rev. ed. 1990) as the sole source material on the underlying science).

63. Ummat et al., *supra* note 49.

64. In biology, the science that studies living organisms, "life" is the condition which distinguishes active organisms from inorganic matter, including the capacity for growth, functional activity and the continual change preceding death. A diverse array of living organisms (life forms) can be found in the biosphere on Earth, and properties common to these organisms—plants, animals, fungi, protists, archaea, and bacteria—are a carbon-, and water-based cellular form with complex organization and heritable genetic information. Living organisms undergo metabolism, maintain homeostasis, possess a capacity to grow, respond to stimuli, reproduce and, through natural selection, adapt to their environment in successive generations. *See* Brig Klyce, What is life?, http://www.panspermia.com/whatis2.htm (last visited Apr. 3, 2010); *see also* DORLAND'S ILLUSTRATED MEDICAL DICTIONARY 920 (27th ed. 1988); J.B.S. HALDANE, WHAT IS LIFE? 58–62 (1949).

65. Reynolds, *supra* note 59, at 188.

66. Diana Bowman & Graeme Hodge, *A Small Matter of Regulation: An International Review of Nanotechnology Regulation*, 8 COLUM. SCI. & TECH. L. REV. 1, 3 (2007).

> There is intensifying awareness around the world of the need to balance the obvious advantages of globalization with its increasingly apparent disadvantages. Regarding arms control, this is demonstrated by a growing need to balance the benefits of greater and more diffuse flows of people, goods, technologies and knowledge—including those relevant to developing weapons of mass destruction (WMD)—with a greater ability to monitor and prevent their misuse towards illicit and violent ends. This conundrum applies across a widening spectrum of current and emergent technologies—such as nuclear technologies, but especially in the biological sciences, including genetic engineering, synthetic biology and nanotechnologies—and, as discussed in this volume, raises new and vexing questions about the appropriate balance between the greater diffusion and the appropriate control of such technological advancements.[67]

From a feasibility standpoint, the most likely application of this smallness to chemical warfare is the reduction of existing banned chemical weapons to a size possibly undetectable by current means and unfilterable by current protective gear, and/or the enhancement of effects of current weapons because of increased toxicity. Those "nano-enhanced" agents are a current concern of a number of entities.

B. *Nano-Enhanced Agents*

The Organisation for the Prohibition of Chemical Weapons("OPCW")[68] conducts conferences to review ongoing chemical weapon developments. As part of its 2008 review conference, the OPCW issued a report by its Scientific Advisory Board on new scientific developments.[69] The report identified

67. Bates Gill, *Introduction* to SIPRI YEARBOOK 2008 2, 2 (2008); *see also* Ronald Sutherland, *Chemical and Biochemical Non-Lethal Weapons: Political and Technical Aspects*, SIPRI POLICY PAPER 23 (2008).

68. The Organisation for the Prohibition of Chemical Weapons ("OPCW") is the implementing body of the Chemical Weapons Convention ("CWC"). The OPCW is given the mandate to achieve the object and purpose of the CWC, to ensure the implementation of its provisions, including those for international verification of compliance with it, and to provide a forum for consultation and cooperation among States Parties. *See* The Organisation for the Prohibition of Chemical Weapons, http://www.opcw.org/about-opcw (last visited Apr. 3, 2010).

69. Organisation for the Prohibition of Chemical Weapons, Second Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention, Apr. 7–18, 2008, *Note by the Director-General: Report of the Scientific*

three immediate areas of concern: the application of nanotech drug delivery systems to dissemination of aerosolized chemical warfare agents, new means of facilitating entry into the body or cells to achieve selective reactions, and, in some cases, higher toxicity than micronized material.[70] Juan Pardo-Guerra and Francisco Aguayo note a concern over "the engineering of task-specific enzymatic regulators [which] could be used for blocking (or over-promoting) key metabolic processes . . . to cause a defined hostile result."[71] They note that "due to their unusual forms of action, such substances would likely be invisible to the existing verification protocols of the [chemical and biological weapons] regime."[72]

These dissemination, entry, and toxicity concerns have been raised in both national and international fora.[73] The U.S. Congressional Research Service has noted that scientific concern[74] about nanoparticles is based in part on some of the very properties that researchers hope to exploit for medical purposes:

> The small size of nanoparticles may allow them to pass easily through skin and internal membranes. This raises questions, however, of whether exposure may be effectively confined to targeted tissues . . . . It is too soon to know whether such questions are serious cause for concern, but there is scientific evidence that some nanoparticles may be hazardous. For example, certain nanoparticles are known to be toxic to microbes, and EPA has reported some studies that have

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Advisory Board on Developments in Science and Technology, Doc. No. RC-2/DG.1 (Feb. 28, 2008), *available at* http://www.opcw.org/index.php?eID=dam_frontend_push&docID=1871.

70. *See id.* ¶¶ 2.5–2.8. Altmann lists similar concerns including use of nanotechnology to provide "capsules for safe enclosure and delayed release," "active groups for bonding to specific targets in organs or cells," "vectors for easier entry[,]" "mechanisms for selective reaction with specific gene patters or proteins," and "reducing friendly risk "by limiting the persistence or an improved binary principle." ALTMANN, *supra* note 36, at 101–02.

71. Pardo-Guerra & Aguayo, *supra* note 61, at 58.

72. *Id.* at 59 (citing Jean Pascal Zanders, *The Chemical Weapons Convention and Universality: A Question of Quality Over Quantity?*, [2002] 4 DISARMAMENT FORUM 23).

73. *See* Zanders, *supra* note 72, at 28.

74. *See, e.g.*, Ian Sample, *Nanotechnology Poses Threat to Health, Say Scientists*, GUARDIAN (London), July 30, 2004, at 2.

> found nanoparticles generally (but not always) *are more toxic than larger particles of identical chemical composition*.[75]

Questions remain, however, at the most basic levels:

> Even among researchers [who focus] on toxicity, there is no agreement about which data might be useful . . . . Scientists have not yet determined which physical-chemical properties (for example, size, shape, composition, stability, or electric charge) will be most important in determining . . . toxicological properties.[76]

The toxicological properties of nanomaterials is in some ways the most urgent concern for enforcers, and at the same time perhaps the least interesting from a juridical viewpoint. There seems to be no possible argument that nano-enhanced poisons are any less banned under the current CWC Annexes than they would be at any other size.[77] More interesting though, is the current emergence of nanodelivery systems in what may be a first step towards autonomous nanomachines.

C. *Nanobots as Delivery Systems*

The most likely immediate scenario for application of nanotechnology[78] to chemical warfare is as a delivery system based on the chemotherapy model. As noted in *The Economist*:

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75. LINDA-JO SCHIEROW, CONG. RESEARCH SERV., ENGINEERED NANOSCALE MATERIALS AND DERIVATIVE PRODUCTS: REGULATORY CHALLENGES 4 (2008) (citations omitted, emphasis added).

76. *Id.* at 7. This information might indicate a need to at least amend the appendix to the CWC, which is, of course, done on an ongoing basis in any case. Interesting issues arise when nanotech meets toxicity. For example, the U.S. Toxic Substances Control Act, 15 U.S.C. § 2601 (2006), excludes nanomaterials that are not "chemical substances," and it defines a "chemical substance" as "any organic or inorganic substance of a particular molecular identity" that is not a mixture. *Id.* § 2602(2). Given this definition, "it might not be clear whether certain nanoparticles consisting of a core inorganic material coated by an organic material would" be covered. SCHIEROW, *supra* note 75, at 12. That sort of legal question demonstrates the potential difficulty of determining coverage by international conventions if they are not read, as was clearly intended, with a very wide reach indeed. *See* discussion *infra* notes 326–36 and accompanying text.

77. The possibility exists, of course, that some of those chemicals may have beneficial attributes in, say, chemotherapy, but exceptions already exist within the CWC regime for certain dual use materials. *See* Chemical Weapons Convention, *supra* note 10, arts. II(9), IV.

78. As opposed to nanoparticles currently in use.

> [A] second generation of nanoparticles has entered clinical trials. Some are so good at hiding their contents away until they are needed that the treatments do not merely reduce side-effects; they actually allow what would otherwise be lethal poisons to be supplied to the tumour only. Others do not depend on drugs at all. Instead, they act as beacons for the delivery of doses of energy that destroy cancer cells physically, rather than chemically.[79]

It is also worth noting that the authors in *Bio-Nanorobotics: The State of the Art* extensively discuss inorganic molecular machines which may have applicability as chemical agent delivery systems:

> In the past two decades, chemists have been able to create, modify and control many different types of molecular machines. Many of these machines carry a striking resemblance with our everyday macroscale machines . . . . Not only this, all of these machines are easy to synthesize artificially, and are generally more robust than the natural molecular machines. Such artificial chemical machines are controllable in various ways [or in more than one way]. A scientist can have more freedom with respect to the design of chemical molecular machines depending on the performance requirements and conditions.[80]

A great deal of work, both private and governmental, is going into research about delivery systems.[81] The publicly available literature is largely devoted to various forms of cancer research; although other medical applications have been discussed.[82] If such carriers are used to deliver poisons or toxins banned under the CWC, their facial illegality for that use again is quite clear.[83] The carriers themselves, however, may very well

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79. *Golden Slingshot; Treating Tumours*, ECONOMIST, Nov.8, 2008, at 73; *see also* Nicholas Wade, *New Cancer Treatment Shows Promise in Testing*, N.Y. TIMES, June 29, 2009, at A7 (reporting that Australian researchers have used "minicells" coated with antibodies to attack tumors, some of which are each "loaded with half a million molecules of . . . a toxin used in chemotherapy.").

80. Ummat et al., *supra*, note 49, at 19-15.

81. *See, e.g.*, NanoRobotics System Lab Homepage, http://www.egr.msu.edu/~ldong/ (last visited Apr. 3, 2010).

82. *See, e.g.*, Awadhesh Kumar Arya, *Applications of Nanotechonology in Diabetes*, 2008 J. NANOMATERIALS & BIOSTRUCTURES, 221, 223 (concerning the treatment of diabetes).

83. As discussed *infra* notes 355–60, the 1925 Geneva Gas Protocol and the CWC would ban the delivered substances outright and make their delivery for military purposes a crime.

have dual usage,[84] and the other uses may be to the medical benefit of humanity.

The National Cancer Institute ("NCI") of the National Institutes of Health explains how nanotechnology is applicable in battling cancer:

> Nanoscale devices are one hundred to ten thousand times smaller than human cells. They are similar in size to large biological molecules ("biomolecules") such as enzymes and receptors. As an example, hemoglobin, the molecule that carries oxygen in red blood cells, is approximately 5 nanometers in diameter. Nanoscale devices smaller than 50 nanometers can easily enter most cells, while those smaller than 20 nanometers can move out of blood vessels as they circulate through the body.
>
> Because of their small size, nanoscale devices can readily interact with biomolecules on both the surface of cells and inside of cells. By gaining access to so many areas of the body, they have the potential to detect disease and deliver treatment in ways unimagined before now. And since biological processes, including events that lead to cancer, occur at the nanoscale at and inside cells, nanotechnology offers a wealth of tools that are providing cancer researchers with new and innovative ways to diagnose and treat cancer.[85]

The NCI then goes on to explain specifically how nanotechnology can be used directly in cancer therapy both as a target for external radiation and as a carrier agent for nanosize does of chemical therapies:

> Nanoscale devices have the potential to radically change cancer therapy for the better and to dramatically increase the number of highly effective therapeutic agents. *Nanoscale constructs can serve as customizable, targeted drug delivery vehicles capable of ferrying large doses of chemotherapeutic agents* or

84. Chemicals under the CWC are divided among "schedules." Schedule 1 lists those chemicals which pose a high risk to the goals of the CWC, including precursor chemicals used to produce nerve agents or mustard agents. Schedule 2 lists those chemicals that generally are not produced in large commercial quantities for nonmilitary purposes and pose a significant risk to the purpose of the CWC. Schedule 3 lists dual-use chemicals which may pose a risk to CWC goals but also have legitimate commercial purposes and are widely produced. *See* Chemical Weapons Convention, *supra* note 10, Annex on Chemicals.

85. The Alliance for Nanotechnology in Cancer: Media Backgrounder, http://nano.cancer.gov/media_backgrounder.asp (last visited Apr. 3, 2010).

> therapeutic genes into malignant cells while sparing healthy cells, greatly reducing or eliminating the often unpalatable side effects that accompany many current cancer therapies.[86]

Thus, much of the nano-related research currently being conducted in medical laboratories is both exciting and terrifying. It offers both the promise of advanced medical treatment for previously incurable diseases, and the threat of more effective means for delivery of lethal chemicals as weapons of mass destruction. The same may be generally said of nanobots. Nanobots which would function solely to mimic existing or future CWC banned chemicals, however, are in a class by themselves. It is those hypothetical weapons which are the core subject of the question posed by the AEPI, and which are a core subject of this Article.

D. *Nanomimics of Existing Banned Weapons*

Finally, there is the AEPI's scenario of "materials that act like chemical agents, . . . but are not classed as chemical agents under any existing protocol."[87] Those would be something other than nano-sized chemical agents. Most likely, to have any chance to avoid the CWC[88] they would have to be nanobots. While some

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86. NATIONAL CANCER INSTITUTE, NANOTECHNOLGY CANCER BROCHURE 12–13 (2004) (emphasis added), *available at* http://nano.cancer.gov/objects/pdfs/cancer_brochure_091609-508.pdf. As a real world example of the promise of nanotechnology in drug delivery, the National Cancern Institute ("NCI") says "Liposomes, which are first generation nanoscale devices, are being used as drug delivery vehicles in several products. For example, liposomal amphotericin B is used to treat fungal infections often associated with aggressive anticancer treatment and liposomal doxorubicin is used to treat some forms of cancer." The Alliance for Nanotechnology in Cancer: Frequently Asked Questions, http://nano.cancer.gov/learn/understanding/faq.asp (last visited Apr. 3, 2010). The NCI also notes that, "[i]n May 2004, two companies (American Pharmaceutical Partners and American BioScience) announced that the FDA accepted the filing of a New Drug Application (NDA) for a nanoparticulate formulation of the anticancer compound taxol to treat advanced stage breast cancer." National Cervical Cancer Coalition: What is Nanotechnology, http://www.nccc-online.org/health_news/research_treatment/what_is_nano.html (last visited Apr. 3, 2010) (citing the NCI).

87. MCGUINNESS, *supra* note 3, at 20.

88. It is not unreasonable to expect that if nanomimics were actually fielded as weapons, the user's chief concern would be their effectiveness as a weapon capable of defeating existing detection and protection systems, rather than on their actual legality. That issue, in the past, seemed to arise more as a reaction to international criticism. *See, e.g.*, German internal discussion and public justification of chlorine gas use in 1915, *infra* text accompanying notes 183–85. The 1977 protocol I, with its requirement of advance

scientists deride the concept as "science fiction,"[89] it is discussed here both because Defense Advanced Research Projects Agency[90] deals in concepts which might have been called "science fiction" twenty years before their development,[91] and also because,

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analysis of the legality of new weapons puts at least a new gloss on that process. *See* discussion, *infra* notes 293–94. If nonstate actors engaged in terrorism obtained such weapons, it is difficult to conceive that a ban in international law would have any positive effect; the point of terrorism is, after all, to terrorize. As those groups move toward state status, however, legal implications might have some impact. An interesting contrast and comparison might be made with the dualistic approaches of the Democratic People's Republic of Korea and its fielding of nuclear weapons, on their perceived interests and resulting acts. *See* Elisabeth Bumiller, *Gates Looks to Tougher Approach on North Korea*, N.Y. TIMES, May 30, 2009, at A8 (describing the international community's approach to North Korea's nuclear testing). An analogy can be drawn here to the movement of certain Palestinian groups from pure terrorism to mixed or quasi-state actor approaches between 1967 and the present. *See, e.g.*, Adam Davidson, *Hamas: Government or Terrorist Organization?*, NPR, Dec. 6, 2006, http://www.npr.org/templates/story/story.php?storyId=6583080.

89. *See, e.g,* RATNER & RATNER, *supra* note 37, at 15–16 ("There are a number of compelling reasons why molecular assemblers are either impossible or at best in our distant future, and it's worth looking in order to read sci-fi without nightmares."). Altmann, on the other hand, list as military risks of nanotechnology both "superintelligent, virtually invisible devices" and "nanoweapons, artificial viruses, [and] controlled biological/nerve agents." ALTMANN, *supra* note 36, at 5. Much of Altmann's work, while interesting, seems highly speculative, even to a layperson. Note the emphasized qualifiers in the following:

> Whereas with MST [microsystems technology], micro-robots of centimeters, *maybe* a few millimeters size *could be* built, NT will *likely* allow development of mobile autonomous systems below 1 mm, *maybe* down to 10 um (this is still 2-3 orders of magnitude above the size range around 100 nm *envisioned for* nano-robots and universal molecular assemblers in MNT).

Id. at 93 (emphasis added); *see also* Judith Reppy, *Nanotechnology for National Security*, *in* NANOTECHNOLOGY: SOCIETAL IMPLICATIONS—INDIVIDUAL PERSPECTIVES 232, 232–35 (Mihail Rocco & William Bainbridge eds., 2007) (discussing the national security implication of nanotechnology, generally); William Tolles, *Vision, Innovation, and Policy*, *in* NANOTECHNOLOGY: SOCIETAL IMPLICATIONS—INDIVIDUAL PERSPECTIVES, *supra*, at 127, 127–30 (arguing that while advances in nanotechnology are vastly important, there needs to be a measure of restraint as well in order to ensure their safe use).

90. *See* About DARPA, http://www.darpa.mil/about.html (last visited Apr. 3, 2010)

91. On March 23, 2007, the Defense Advanced Research Projects Agency ("DARPA") issued a requesting soliciting proposals for the development of "Chemical Robots" capable of manipulating their shape in order to traverse small openings. *See* Def. Advance Research Projects Agency, Special Focus Area: Chemical Robots BAA, Solicitation No. BAA07-21, add. 2 (Mar. 27, 2001), *available at* https://www.fbo.gov/?id=30ae77f2004313f28bf4d07947e0b4d6. The DARPA request specifies that the ChemBots should be "soft, flexible, mobile objects that can identify and maneuver through openings smaller than their static structural dimensions." *Id.* It goes on to add that, "nature provides many examples of ChemBot functionality. Many soft creatures, including mice, octopi, and insects, readily traverse openings barely larger than their largest 'hard' component." *Id.*; *cf.* TERMINATOR 2: JUDGMENT DAY (TriStar Pictures 1991)

especially in warfare, many science fiction scenarios have become science fact.[92] It is, in this context, worth noting, in its entirety, an August 2009 report in the Science Times section of the *New York Times*:

> You can't build a machine without parts. That's true for large machines like engines and pumps, and it's true for the tiniest machines, the kind that scientists want to build on the scale of molecules to do work inside the body. Researchers at the Dana-Farber Cancer Institute and Harvard University have taken a step toward creating parts for molecular machines, out of DNA. In a paper in *Science*, Hendrick Dietz . . . Shawn M. Douglas and William H. Shih describe a programmable technique for twisting and curving DNA into shapes. Dr. Shih said the method used strands of DNA that self-assembled into rigid bundles, with the individual double helixes joined by strong cross-links. Manipulating the base pairs in the helixes—using more or fewer of them between cross-links—creates torque that causes the bundles to twist and bend in a specific direction. The researchers were able to control the degree of bending, and were even able to make a bundle bend back on itself. The researchers built several structures, including a 12-tooth gear and a wire-frame ball. Dr. Shih said that while it was possible that a future molecular machine might use parts like these, the work was meant to demonstrate that "if you want to make a machine, you are going to need very precise fabrication ability." The goal, he added, *is to make objects that are far more complex and eventually build a machine that could, say, deliver a drug to a precise spot in the body*. Dr. Shih likened the work to the development of integrated circuits, where complexity has roughly doubled every 18 months for the past 40 years. "We're motivated to improve the technology," he said.[93]

(depicting "the T-1000 compound, composed of a mimetic polyalloy, a liquid metal that allows it to take the shape and appearance of anything it touches"). The contract was ultimately awarded to Tufts University. *See Tufts Joins the Chembot Creation Challenge with $3.3M DARPA Contract*, MASS HIGH TECH, June 30, 2008, http://www.masshightech.com/stories/2008/06/30/daily8-tufts-joins-the-chembot-creation-challenge-with-$3.3m-darpa-contract.html.

92. *See generally* H.G. WELLS, THE WAR OF THE WORLDS (1898) (portraying a scenario where alien invaders die from Earth bacteria). See discussion about the Geneva Protocol, *infra* note 110, where biological weapons are banned though undeveloped.

93. Henry Fountain, *Scientists Use Curvy DNA to Build Molecular Parts*, N.Y. TIMES, Aug. 11, 2009, at D3 (quoting doctor William H. Shih) (emphasis added). For a copy of

Shortly before press time for this article, the Wall Street Journal published an item headlined "Tiny Robots Made of DNA Can Walk, Pivot, Work with Microscopic Forklifts." It said, in part:

> For the first time, microscopic robots made from DNA molecules can walk, follow instructions and work together to assemble simple products on an atomic-scale assembly line, mimicking the machinery of living cells, two independent research teams announced Wednesday.
>
> These experimental devices, described in the journal Nature, are advances in DNA nanotechnology, in which bioengineers are using the molecules of the genetic code as nuts, bolts, girders and other building materials, on a scale measured in billionths of a meter. The effort, which combines synthetic chemistry, enzymology, structural nanotechnology and computer science, takes advantage of the unique physical properties of DNA molecules to assemble shapes according to predictable chemical rules.
>
> . . .
>
> These new construction projects bring researchers a step closer to a time when, at least in theory, scientists might be able to build test-tube factories that churn out self-assembling computers, rare chemical compounds or autonomous medical robots able to cruise the human bloodstream.
>
> . . .
>
> In the first project, a team of scientists led by biochemist Milan Stojanovic at Columbia built a molecular robot that moved on its own along a track of chemical instructions-the DNA equivalent of the punched paper tape used to control automated machine tools.
>
> Once programmed, the robot required no further human intervention, the researchers reported. It could turn, move in a straight line or follow a complex curve and then stop, all essentially on its own initiative. They documented its progress with an atomic force microscope as it strode along a path 100 nanometers long, about 30 times further than earlier DNA walkers could manage.

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the original study, see Hendrik Dietz et al., *Folding DNA into Twisted and Curved Nanoscale Shapes*, SCIENCE, Aug. 7, 2009, at 725–30.

> "*In the future, this could be used as a molecular machine that could bind to a cell surface, maybe carry a cargo and release something*," said biochemist Hao Yan at the Biodesign Institute at Arizona State University, one of 12 researchers at four universities involved in the project.[94]

The Arms Control Association recognized many of these potential issues in 2004 and suggested possible legal responses:

> Many of the international legal tools to prevent the development of these weapons are already in place, notably the [BWC] and the [CWC], which together ban military use of all of the weapons imagined here. Nevertheless, these may prove insufficient to prevent proliferation, and we should not shy away from new international treaties as necessary. Foremost among the new treaties that should be considered, or reconsidered, are those that would: add a compliance regime to the 1972 BWC; make development, possession, or use of chemical or biological weapons a crime over which nations may claim universal jurisdiction (like piracy, airline hijacking, and torture); and impose a single control regime over the possession and transfer of dangerous pathogens and toxins. Consideration should also be given to a new convention that would prohibit the nonconsensual manipulation of human physiology, to support and extend the provisions of the CWC, BWC, and international humanitarian law.[95]

What the arms control experts seems to have in mind is not the "gray goo" scenario,[96] or bots attacking soldiers of a specific genetic make-up,[97] though both have been discussed by legal writers. Rather, the concern is that a nanobot that could target nerve cells or their receptors and block cholinesterase production through mechanical means is certainly conceivable.[98] The result would be precisely the same in terms of effects and

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94. Robert Lee Hotz, *A Factory that Fits on a Pin—New Robots Made of DNA Can Walk, Pivot, Work with Microscopic Forklifts*, WALL ST. J., May 13, 2010, at A3.

95. Mark Wheelis, *Will the New Biology Lead to New Weapons?*, ARMS CONTROL TODAY, July–Aug. 2004, at 23.

96. "Gray goo" is a term popularized by Eric Drexler in his book *Engines of Creation*, *supra* note 27, at 172–73, to describe self-replicating nanobots run amok. *See* Lawrence Osborne, *The Gray-Goo Problem*, N.Y. TIMES MAG., Dec. 14, 2003, at 17.

97. *See* ALTMANN, *supra* note 36, at 102.

98. For a general overview of nano-nerve targeting, see Surfdaddy Orca, *Targeting Nerve Cells with Nanoparticles*, H+ MAG., Oct. 6, 2009, http://www.hplusmagazine.com/articles/nano/targeting-cancer-cells-nanoparticles.

lethality as the V-series of nerve gases,[99] but with the potential for enhanced deliverability.[100] Delivery (dissemination and dispersion) methods are important to this discussion because nanoproducts are different in so many ways from the norm.[101] In

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99. TUCKER, *supra* note 42, at 154 (detailing the effects of a V-series agent on the body). For more information on difference between V-series and G-series nerve agents, see *supra* note 45. Gas is subject to dispersion and dissipation effects from time and weather which might not affect machines in the same manner. *See* TUCKER, *supra* note 42, at 158–59.

100. Both because existing filters and detectors could be ineffective, and because dispersion in new forms may become available. *See* RATNER & RATNER, *supra* note 37, at 44.

101. The Federation of American Scientists' website does a very good job at illustrating this distinction:

> Perhaps the most important factor in the effectiveness of chemical weapons is the efficiency of dissemination. . . . The principal method of disseminating chemical agents has been the use of explosives. These usually have taken the form of central bursters expelling the agent laterally.Efficiency is not particularly high [due to] incineration . . . . Particle size will vary, since explosive dissemination produces a bimodal distribution of liquid droplets of an uncontrollable size . . . . The efficacy of explosives and pyrotechnics for dissemination is limited by the flammable nature of some agents. . . . Aerodynamic dissemination technology allows non-explosive delivery from a line source. Although this method provides a theoretical capability of controlling the size of the particle, the altitude of dissemination must be controlled and the wind direction and velocity known. . . . An important factor in the effectiveness of chemical weapons is the efficiency of dissemination as it is tailored to the types of agent. The majority of the most potent of chemical agents are not very volatile. . . . The agent must be dispersed within the boundary layer (<200-300 ft above the ground) and yet high enough to allow effective dispersal of the agent. . . . A more recent attempt to control aerosol particle size on target has been the use of aerodynamic dissemination and sprays as line sources. *By modification of the rheological properties of the liquid, its breakup when subjected to aerodynamic stress can theoretically be controlled and an idealized particle distribution achieved. In practice, the task is more difficult, but it represents an area where a technological advance could result in major munition performance improvements.* The altitude of dissemination must be controllable and the wind direction and velocity known for a disseminated liquid of a predetermined particle size to predictably reach the ground and reliably hit a target. Thermal dissemination, wherein pyrotechnics are used to aerosolize the agent[,] has been used particularly to generate fine, inhalable clouds of incapacitants. Most of the more complex agent molecules, however, are sensitive to high temperatures and can deteriorate if exposure is too lengthy. Solids are a notoriously difficult problem for dissemination, since they tend to agglomerate even when pre-ground to desired sizes. Dispersion considers the relative placement of the chemical agent munition upon or adjacent to a target immediately before dissemination so that the material is most efficiently used. For example, the artillery rockets of the 1950's and early 1960's employed a multitude of submunitions so that a large number of small agent clouds would form directly on the target with minimal dependence on

addition to the different physics and biology inherent in their small size,[102] swarming,[103] and emergence[104] technologies may allow precise dosing by terminating targeting once a lethal dose has been achieved.[105]

How much of this really is science fiction, one can only speculate. It is interesting, though, that BBC News reported in 2008 that:

> A tiny chemical "brain" which could one day act as a remote control for swarms of nano-machines has been invented. The molecular device—just two billionths of a metre across—was able to control eight [nanomachines] simultaneously in a test. . . . "If [in the future] you want to remotely operate on a tumour you might want to send some molecular machines there," explained Dr. Anirban Bandyopadhyay of the International Center for Young Scientists, Tsukuba, Japan. . . . "But you cannot just put them into the blood and [expect them] to go to the right place." Dr. Bandyopadhyay believes his device may offer a solution. One day you may be able to guide the nanobots through the body and control their functions, he said.[106]

> meteorology. Another variation of this is multiple "free" aerial sprays such as those achieved by the BLU 80/B Bigeye weapon and the multiple launch rocket system. While somewhat wind dependent, this technique is considerably more efficient in terms of agent quantities. In World War I, canisters of chlorine were simply opened to allow the gas to drift across enemy lines. Although this produced limited results, it is indicative of the simplicity of potential means of dispersion . . . . There is sufficient open literature describing the pros and cons of various types of dissemination to dictate the consideration of all of them by a proliferant.

Federation of American Scientists: Chemical Weapons Delivery, http://www.fas.org/programs/ssp/bio/chemweapons/delivery.html (last visited Apr. 3, 2010) (emphasis added).

102. *See* ALTMANN, *supra* note 36, at 1.

103. *See generally* Sean J. A. Edwards, Swarming and the Future of Warfare, (Sept. 2004) (unpublished Ph.D. dissertation, Pardee Rand Graduate School), *available at* http://www.rand.org/pubs/rgs_dissertations/2005/RAND_RGSD189.pdf) (describing swarming as an effective warfare tactic when military operations are decentralized and non-linear).

104. *See generally* Peter A. Corning, *The Re-Emergence of "Emergence": A Venerable Concept in Search of a Theory, Institute for the Study of Complex Systems*, COMPLEXITY, July–Aug. 2002, at 18. (recounting the history of the term "emergence" and detailing some of its current usages).

105. A simple emergence feedback limit could, for example, direct devices elsewhere once an underlying prime concentration level had been achieved.

106. Jonathan Fildes, *Chemical Brain Controls Nanobots*, BBC NEWS, Mar 11, 2003, http://news.bbc.co.uk/nol/ukfs_news/mobile/newsid_7280000/newsid_7288400/

It is the prospect of a self-guided nanobot, self-controlling their functions, which seems to particularly trouble military commentators.[107] As the AEPI asked, are "nanomachines . . . chemical weapons under the provisions of the Chemical Weapons Convention?"[108]

To answer that question, others need to be answered: What are the currently applicable treaties, and do they need to be modified? To understand their reach it is necessary to first begin with the core treaty which is still binding, and which is incorporated in all other currently applicable law, the 1925 Geneva Gas Protocol.[109] Indeed, to understand where we are today, we must closely examine the protocol's history, reaching back to the 19th century.

II. *TREATIES APPLICABLE TO NANOWEAPONS*

A. *Facially Applicable Treaties*

Several treaties are facially applicable to at least some nano-related weapons. They include the 1925 Geneva Gas Protocol, as well as the more recent Biological and Chemical Weapons Conventions. Because their background and negotiation are directly relevant to their coverage, this Article deals with those points in considerable detail.

1. The 1925 Geneva Gas Protocol

The 1925 Geneva Gas Protocol ("1925 Protocol") was an important step in global attempts to ban chemical and biological weapons but it was neither the first, nor the only step.[110] In its

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7288426.stm (second alteration in original); *see also* Anirban Bandyopadhyay & Somobrata Acharya, *16-Bit Parallel Processing in a Molecular Assembly*, 105 PROC. NAT'L ACAD. SCI. 3668, 3668 (2008) (describing how a 16-bit molecular assembly machine "represents a significant conceptual advance to today's fastest processors, which execute only one function at a time").

107. *See, e.g.*, MCGUINNESS, *supra* note 3, at 14; Henley, *supra* note 56, at 5; Nygren, *supra* note 6, at 15.

108. *See* MCGUINNESS, *supra* note 3, at 27.

109. Geneva Protocol, *supra* note 23.

110. A quarter of a century earlier, the second declaration produced by the first Hague Peace Conference in 1899 provided that "The Contracting Powers agree to abstain from the use of projectiles the object of which is the diffusion of asphyxiating or deleterious gases." Declaration (IV, 2) Concerning Asphyxiating Gases, Jul. 29, 1899, 187 Consol. T.S. 453, *reprinted in* THE HAGUE CONVENTIONS AND DECLARATIONS OF 1899

article-by-article review of the CWC prior to U.S. ratification, the Defense Treaty Inspection Readiness Program ("DTIRP") noted that:

> The fourth preambular paragraph [of the CWC] recognizes that the Convention reaffirms the principles and objectives of, and obligations assumed under, the Geneva Protocol of 1925 and [the BWC] . . . . The Geneva Protocol of 1925, read together with the reservations made to it, *amounts to a ban on the first use of chemical weapons* insofar as it relates to the United States.[111]

How did that ban on poison gas come into effect, and what does it cover? The first question is important to understand the intent of the drafters and signatories; the second is vital since its terms are incorporated into and reiterated by both the CWC and the BWC,[112] and are unquestionably current and binding international law.

AND 1907, at 250 (James Brown Scott ed., 3d ed. 1918) [hereinafter "Hague Asphyxiating Declaration"]. The 1925 Protocol represents the first multilateral treaty actually coming into effect which, at least in some instances, banned first use of chemical weapons in armed conflicts. It was only applicable to signatory parties, and was subject to use of chemical weapons for reprisal, but it proved, as discussed below, surprisingly effective. Even nonsignatory states, such as the United States (which signed but did not obtain Senate ratification until 1975), repeatedly declared their intention to abide by its terms in wartime. *See* Barton J. Bernstein, *Why We Didn't Use Poison Gas in World War II*, AM. HERITAGE, Aug./Sept. 1985,. at 40 ("During World War II, international law did not actually bar the United States from using gas warfare—although America had signed the 1925 Geneva. Protocol outlawing gas, the Senate had never ratified it. Yet every peacetime President from Warren G. Harding to Franklin D. Roosevelt had defined gas as immoral and pledged to abide by the agreement.").

111. S. TREATY DOC. NO. 103-21, at 2 (1993) (emphasis added); *see also* Chemical Weapons Convention, *supra* note 10, art. XIII ("Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the 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 17 June 1925, and under the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, signed at London, Moscow and Washington on 10 April 1972").

112. The 1925 Geneva Gas Protocol was later incorporated into the preamble to the Biological Weapons Convention:

> Recognising the important significance of the 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 June 17, 1925, and conscious also of the contribution which the said Protocol has already made, and continues to make, to mitigating the horrors of war,
>
> Reaffirming their adherence to the principles and objectives of that Protocol and calling upon all States to comply strictly with them,

a. Why Gas Mattered

It is not often that legal analysis can legitimately coalesce with picture and poem, but I can think of no better way to give some flavor to the contemporary reader of the horror with which the general public and the average veteran viewed gas warfare in the decade after the end of the Great War. The work reproduced below is the pictorial counterpoint to Wilfred Owen's poetry[113]

> Recalling that the General Assembly of the United Nations has repeatedly condemned all actions contrary to the principles and objectives of the Geneva Protocol of June 17, 1925

Biological Weapons Convention, *supra* note 13, pmbl. Similarly, the preamble to the Chemical Weapons Convention provides in part: "*Recognizing* that this Convention *reaffirms* principles and objectives of and *obligations assumed under the Geneva Protocol of 1925*, and the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction signed at London, Moscow and Washington on 10 April 1972." Chemical Weapons Convention, *supra* note 10, pmbl. (second emphasis added).

113. Most especially, being Owen's completely accurate and terribly effective *Dulce et Decorum Est*. Wilfred Owen, *Dulce et Decorum Est*, *in* THE COLLECTED POEMS OF WILFRED OWEN 55 (C. Day Lewis ed., Pantheon 1964). The author has never come across a better description of the sensations that he experienced when masking in a U.S. army practice gas chamber than "an ecstasy of fumbling." *Id.* Contemporary descriptions of German gas shells affirm their unique sound of Owen's "hoots." *See, e.g.*, L.F. HABER, THE POISONOUS CLOUD: CHEMICAL WARFARE IN THE FIRST WORLD WAR 189, 192 (1986) (describing the noise that Allied forces associated with the detonation of gas shells as a distinctive "plop"). The poem reads in full:

> Bent double, like old beggars under sacks,
> Knock-kneed, coughing like hags, we cursed through sludge,
> Till on the haunting flares we turned our backs
> And towards our distant rest began to trudge.
> Men marched asleep. Many had lost their boots
> But limped on, blood-shod. All went lame; all blind;
> Drunk with fatigue; deaf even to the hoots
> Of tired, outstripped Five-Nines that dropped behind.
>
> Gas! Gas! Quick, boys!—An ecstasy of fumbling,
> Fitting the clumsy helmets just in time;
> But someone still was yelling out and stumbling,
> And flound'ring like a man in fire or lime . . .
> Dim, through the misty panes and thick green light,
> As under a green sea, I saw him drowning.
>
> In all my dreams, before my helpless sight,
> He plunges at me, guttering, choking, drowning.
>
> If in some smothering dreams you too could pace
> Behind the wagon that we flung him in,
> And watch the white eyes writhing in his face,
> His hanging face, like a devil's sick of sin;

which epitomized the popular revulsion against the war, politicians, industry, and propaganda that seized the general public, especially in the Western democracies, at the end of the war.[114]

Figure 1. John Singer Sargent, *Gassed* (Imperial War Museum, London 1918–1919). Reprinted from John Singer Sargent Virtual Gallery, http://www.jssgallery.org/paintings/gassed/gassed.htm.

That horror, especially with gas warfare,[115] was a tangible thing which directly affected international policy after November 11, 1918.[116] "The public . . . was influenced by many dramatic

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If you could hear, at every jolt, the blood
Come gargling from the froth-corrupted lungs,
Obscene as cancer, bitter as the cud
Of vile, incurable sores on innocent tongues,—
My friend, you would not tell with such high zest
To children ardent for some desperate glory,
The old Lie; Dulce et Decorum est
Pro patria mori.

Id. Among the many other English language "war poets" were Edmund Blunden, Robert Graves, Isaac Rosenberg, and Siegfried Sassoon. *See* THE PENGUIN BOOK OF FIRST WORLD WAR POETRY (George Walter ed., 2004); *see also* THE OXFORD BOOK OF WAR POETRY (Jon Stallworthy ed., 1984).

114. In Sargent's painting the sky is yellow in the aftermath of a mustard gas attack. Mustard gas may appear as a yellow-brown cloud, but if it was present in the levels presented, the soldiers in the painting would not be standing in line unmasked. *See* Mustard Gas - Council on Foreign Relations, http://www.cfr.org/publication/9551/#p1 (last visited Apr. 3, 2010). Rather, Sargent is adding to the horror of the viewer with a certain level of artistic license.

115. *See, e.g.*, JOHN ELLIS, EYE DEEP IN HELL: TRENCH WARFARE IN WORLD WAR 1, 65-68 (1976) (quoting, among others, a nurse as saying, "I wish those people . . . could see the poor things burnt and blistered all over with great mustard-coloured suppurating blisters, with blind eyes . . . all sticky and stuck together, and always fighting for breath, with voices a mere whisper, saying that their throats are closing and they know they will choke.").

116. Ludwig Haber notes that:

illustrations of gas warfare in photographs and some deeply moving paintings. Gas was looked on as something particularly wicked, something unfair and cowardly, against which a 'fair fight' was impossible."[117]

Certainly, gas proponents knew that intense distaste was a threat to their future. The Chemical Warfare Service of the United States Army, and the U.S. chemical industry, especially Dupont[118] and Dow Chemical,[119] had a vested interest in the continued use of poison gases as weapons of war. As early as 1921 Brigadier General Amos Fries, the chief of what was then the Army's Chemical Warfare Service, argued that:

> [R]omanticism versus technology had a powerful intellectual attraction to many famous authors, and it led directly to the campaigns for the control of what the French called "*armes désloyales*" for which the nearest translation is "unfair weapons". The argument even had its technical side: many infantry and artillery officers were baffled by poison gas . . . . Finally, we need to bear in mind that until 1918 the British and the French were more affected by gas than the Germans. . . . [I]n the course of 1918 the situation altered. . . . [I]n the last year of the war, German writers . . . changed their perceptions. [Eric Maria] Remarque's All Quiet on the Western Front . . . reached a vast audience and with him . . . effects of the First World War on the minds of the masses began.

HABER, *supra* note 113, at 231. See also Haber's discussion of Sargent's *Gassed*, *supra* note 114; Owen's *Dulce et Decorum Est, supra* note 113; HABER, *supra* note 113, at 233; and TIM COOK, NO PLACE TO RUN, THE CANADIAN CORPS AND GAS WARFARE IN THE FIRST WORLD WAR 7–8 (1999) (presenting Owen's poem as "the true face of poison gas . . . .").

117. WILLIAM MOORE, GAS ATTACK: CHEMICAL WARFARE 1915–18 AND AFTERWARDS 195 (1987).

118. *See* SPECIAL COMM. INVESTIGATION OF THE MUNITIONS INDUS., PARTIAL PRELIMINARY REPORT ON WARTIME TAXATION AND PRICE CONTROL, S. REP. NO. 74-944, pt. 3, at 3–13 (1936).

119. *See Munitions Industry: Hearings Before the Spec. Comm. Investigating the Munitions Industry Pursuant to S. Res. 206,* 73d Cong., pt. 11, at 2564–68 (1934) [*Spec. Comm. Hearings on Munitions*] (exhibit to testimony reproducing a speech delivered by William J. Hale, Vice President of Dow Chemical Company). The U.S. chemical dye industry desired both a protective tariff and an embargo on chemical imports into the United States, ostensibly to protect the industry's readiness and ability to produce chemical weapons. *See* FREDERIC BROWN, CHEMICAL WARFARE: A STUDY IN RESTRAINTS 56–59 (1968). Brown notes that, "[t]he propaganda used by the dye industries was both virulent and effective. . . . In short, a continuous stream of gas propaganda was maintained throughout the early 1920's." *Id.* at 59. In arguing for a protective tariff before a professional fraternal organization, Doctor William Hale described gas as "the most effective weapon of all time [and] the most humane ever introduced into war by man." *Spec. Comm. Hearings on Munitions*, *supra*, at 2565. He then went on to state, "In this war after the war our battle cry must be 'To Hell with all the German imports! Down with every thing opposed to American industries!'" *Id.* at 2568.

> [Gas] is far from being the most horrible form of warfare, provided both sides are prepared defensively and offensively. Medical records show that out of every 100 Americans gassed, less than two died, and as far as records of four years show, very few are permanently injured. . . . Various forms of gas . . . make life miserable or vision impossible to those without a mask. Yet they do not kill.[120]

Fries' chapter on "The Future of Chemical Warfare" is telling, both for what it says and for the defensive language it uses about critics of gas as a legitimate weapon:

> The pioneer, no matter what the line of endeavor, encounters difficulties caused by his fellow-men just in proportion as the thing pioneered promises results. . . . [If] the results promises to be great, and especially if the rewards

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120. AMOS FRIES & CLARENCE WEST, CHEMICAL WARFARE 13 (1921). Fries expanded on that position in his testimony before the United States Senate:

> I consider [gas] one of the most important agents in any possible future war. It caused, even in the last war, when the Germans never fully realized the power of it until it was too late, and the enemy was never able to produce all he wanted—it caused over 27 per cent of all the American casualties, although the death rate was very light from gas. If you take out the deaths from other causes, the percentage of wounded rises to almost one third of all our wounded.

Tariff Act of 1921 and Dyes Embargo: Hearing on H.R. 7456 Before the Comm. on Finance, 67th Cong. 387 (1921) (statement of Amos Fries, Brigadier General). Robert Harris and Jeremy Paxman would respond later:

> [A]dvocates of chemical warfare later argued that gas was actually the most *humane* of the weapons used in the First World War, wounding far more than it killed. But the figures do not reveal either the horror or the persistence of gas wounds. Nor do they show the psychological casualties. As the fighting dragged on, the constant state of gas readiness imperceptibly sapped men's strength and fighting spirit.

ROBERT HARRIS & JEREMY PAXMAN, A HIGHER FORM OF KILLING 18 (2002).

> [T]here appears to have been a deliberate campaign to underestimate the number of men killed and wounded by gas. Officially, 180,193 British soldiers were gassed, of whom just 6,062 were killed. However, the list of categories these numbers *do not* include is staggering. . . . Apologists for gas warfare used the statistics to argue that gas was "humane" . . . . And what of the victims of these "civilized" weapons? In Britain in 1920, 19,000 men were drawing disability pensions as a result of war gassing. . . . In 1929 Porton [Down Research Station] investigated a further seventy-two cases of mustard gassing and found evidence of fibrosis, TB, persistent laryngitis, TB of the spine, anemia, aphonia, conjunctivitis and pulmonary fibrosis. These, of course, were secret reports, only declassified years later. In public, Porton maintained that the popular press "scare-mongered" about the long term effects of gas poisoning.

Id. at 36–37.

> promised to the investor and those working with him promises to be considerable, the difficulties thrown in the way of the venture become greater and greater. Indeed, whenever great results are promised, envy is engendered in those in other lines whose importance may be diminished or who are so short-sighted as to be always opposed to progress.[121]

Fries' anger at what he clearly considered the ignorance and illogic of those who oppose gas warfare come through at the conclusion of his book:

> [W]hat should . . . any highly civilized country consider giving up chemical warfare. To say that its use against savages is not a fair method of fighting, because the savages are not equipped with it, is arrant nonsense. No nation considers such things today. If they had, our American troops, when fighting the Moros in the Philippine Islands, would have had to wear the breechclout and use only swords and spears. Notwithstanding the opposition of certain people who, through ignorance or for other reasons, have fought it, chemical warfare has come to stay . . . . It is just as sportsman-like to fight with chemical warfare as it is to fight with machine guns. . . The American is a pure sportsman and asks odds of no man. He does ask, though, that he be given a square deal. He is unwilling to agree not to use a powerful weapon of war when he knows that an outlaw nation would use it against him . . . . How much better it is to say to the world that we are going to use chemical warfare to the greatest extent possible in any future struggle.[122]

Fries, as it turns out was incorrect in his expectations,[123] but for a very long time his arguments carried a great deal of weight.[124] What they demonstrate here is the other side of a long and bitter conflict about the morality of using poison gas in war.

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121. *Id.* at 435. Fries' comments here appear to be aimed at officers of other branches who thought chemical warfare dishonorable, ineffective, or both. *See, e.g.*, discussion of intervention by U.S. representatives in negotiations for the Washington Naval Treaty in 1922, *infra* at 215.

122. *Id.* at 438–39.

123. Eventually, there was a complete ban on possession and development though it took over seventy years.

124. For example, Fries was cited in and supported by Russell Ewing, *The Legality of Chemical Warfare*, 61 AM. L. REV. 58 (1927), who argued that:

> In defiance of facts, experience and history, the nations of the world are still striving to outlaw chemical warfare. This is due in part to blind ignorance, lack

b. Efforts to Regulate Poisons and Gases Before World War I

There had, in fact, been considerable discussion of poisonous and asphyxiating gases before their wide use began in 1915. Part of the reason was the recognition of the illegality of poisonous weapons articulated in U.S. Army General Order 100 in 1863.[125] Another was the philosophy articulated by Czar Nicholas II of Russia in his proposition for what became the Hague Conference of 1899: "Hundreds of millions are devoted to acquiring terrible engines of destruction, which, though today regarded as the last word of science, are destined tomorrow to lose all value in consequence of some fresh discovery in the same field."[126]

> of imagination, and, in no small degree, to misinformation. It may seem incredible but we have a situation in this country where the American Legion, a group of men who have fought in the last war and many of whom would fight in the next one should another come, favor chemical warfare as over against other weapons while the President and his administration are opposed to its use and are attempting to outlaw it.

Id. at 60. He adds that:

> [A]nti-gas sentiment as embodied in the [1925 Geneva Gas Protocol] but the only logical conclusion that can be drawn is that it was insincere. The delegates had their ears to the ground and followed the popular clamor of the moment, disregarding history, the established practice, and the admitted facts regarding the efficiency and humanity of chemical warfare. Such has always been the course of these so-called world conferences. They proclaim some . . . scheme . . . only to be soon forgotten or disregarded.

Id. at 73. He concludes:

> Owing to the primordial aversion to the new, combined with prejudice, propaganda, and the desire of statesmen and diplomats for popular acclaim, it has been easy in peace time to secure conventions of this nature. But when whole populations become fanned into a passion and war in all its grim and sordid reality comes, "military necessity" will compel the contending parties to employ the most efficient weapons at their disposal.

Id. at 75–76.

125. *See* FRANCIS LIEBER, INSTRUCTIONS FOR THE GOVERNMENT OF ARMIES OF THE UNITED STATES IN THE FIELD (Gov't Printing Office 1898) (1863) (initially published as U.S. War Dep't, General Orders No. 100 (Apr. 24, 1863)). The so-called "Lieber Code" was named for its principal initial drafter Columbia University law professor Francis Lieber. The Lieber Code was widely accepted by European powers in the decades following its promulgation. *See* FRANCIS LEIBER, AND THE CULTURE OF THE MIND 58 (Charles R. Mack & Henry H. Lesesne eds., 2005) Its significance to the laws of war cannot be overstated. *See* JOSEPH H. CHOATE, THE TWO HAGUE CONFERENCES 13 (1913) ("This [1899 Hague Conference] codification of the laws and customs of land warfare was based on the Laws and Customs of Warfare adopted by the Brussels Conference in 1874, which in turn grew out of Dr. Francis Lieber's Instructions for the Government of Armies in the Field, Known as General Order 100 of 1863.").

126. CHOATE, *supra* note 125, at 5–6.

Choate discusses the gas provision of the First Conference: "In the same spirit of humanity, the Conference of 1899, after much discussion, agreed to abstain from the use of projectiles, the object of which is the diffusion of asphyxiating of deleterious gases . . . ."[127] In fact, in 1899 it was the Russian delegate who introduced the asphyxiating gases proposal, and who, when others objected that all explosives produced gases which might asphyxiate, defined the prohibition to "include only those projectiles whose object is to diffuse asphyxiating gases, and not to those whose explosion produces incidentally such gases."[128] Choate then discusses the prohibition, at the 1907 Conference, of the launching of projectiles from balloons, which he says was embodied in the comment of a British delegate who asked what purpose would "be served by the protective measures already adopted for war on land, if we open to the scourge of war a new field more terrible perhaps than all the others?"[129]

The second Hague reiteration of the 1899 ban on poison weapons,[130] and the continuation of the 1899 limits on asphyxiating gases seemed quite clear, and yet eight years after the 1907 Convention, Germany deployed chlorine gas at Ypres, Belgium.[131] What happened in 1915 and in the ensuing years of World War I and, more importantly for present purposes, what impact did the use of gas and its rationale at the time have on Post-World War I treaty making?

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127. *Id.* at 15. But note, that in 1899, Captain Alfred Thayer Mahan, then the U.S. delegate, and later author of the highly influential THE INFLUENCE OF SEAPOWER UPON HISTORY 1660-1783 (Pelican Publishing Company 2003) (1890), voted against banning gas and argued that no practical asphyxiating shell had been developed and there was no proof it would be crueler than other forms of warfare. CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE, INSTRUCTIONS TO THE AMERICAN DELEGATES TO THE HAGUE PEACE CONFERENCES AND THEIR OFFICIAL REPORTS 36 (1916); s*ee also* Hague Asphyxiating Declaration, *supra* note 110.

128. WILLIAM HULL, THE TWO HAGUE CONFERENCES AND THEIR CONTRIBUTIONS TO INTERNATIONAL LAW 87 (1908).

129. *Id.* at 14 (quoting Lord Reay, one of the British delegates).

130. *Compare* Convention with Respect to the Laws and Customs of War on Land Annex art. XXIII, July 29, 1899, 32 Stat. 1803, 1 Bevans 247 ("[I]t is especially prohibited . . . [t]o employ poison or poisoned arms . . . ."), *with* Convention Respecting the Laws and Customs of War on Land Annex art. 23, Oct. 18, 1907, 36 Stat. 2277, 1 Bevans 631 ("[I]t is especially prohibited . . . [t]o employ poison or poisoned arms . . . .").

131. *See, e.g.*, SIMON JONES, WORLD WAR GAS WARFARE TACTICS AND EQUIPMENT 4–8 (2007) (chronicling the the decision to use gas shells and the siege of Ypres).

c. What Happened in the Great War?

At the very core of the legal dispute involving German use of gas in 1915 were drafting ambiguities in the pertinent treaties: Did "asphyxiating" cover gases which worked through other means such as skin absorption? Did "poison" cover nonlethal or allegedly nonlethal weapons? Was release of gas from cylinders within the coverage of the ban on "projectiles?" Were fine powders considered as gases if they had the same effect?

Germany's arguments were widely discussed both during, and immediately after the war. Germany took the position that France had made "prior use of asphyxiating gases."[132] It cited instructions issued by the French Ministry of War on February 21, 1915 concerning grenades and gas cartridges containing "stupefying gases," the purpose of which was to "make untenable the surroundings of the place where they burst."[133] The instructions provided that "the vapors [of the] asphyxiating gases are not deadly, at least when small quantities are used."[134] The Germans took the position that, of necessity, the French were admitting the gases were deadly in large quantities, and that they were simply reprising with their later attacks.[135]

Ludwig F. Haber, the son of the man who was held responsible for Germany's use of chlorine gas in 1915,[136] has published an extensive study of the subject:

> The spirit of the Conventions was surely clear enough: to stop new and potentially more awful weapons. But the letter was obscure and open to widely differing interpretations . . . . When the Germans used gas at Ypres, they were held to be in breach of the Conventions on several counts . . . [Germany] argued at the time, and later, that (i) the Conventions did not cover gas blown from cylinders, (ii) the Allies had used gas first, (iii) gases were not poisonous, and (iv) after the war, gas shells were implicitly excluded because they were not causing needless suffering . . . . [Haber seems to

132. *Official German Press Report of June 25, 1915*, *in* 3 THE GREAT EVENTS OF THE GREAT WAR 138, 138 (Charles F. Horne ed., 1920).

133. *Id.*

134. *Id.* at 139.

135. *See id.*

136. Doctor Fritz Haber, 1868–1934, winner of the Nobel Prize for Chemistry in 1918. *See generally* DIETRICH STOLTZENBERG, FRITZ HABER: CHEMIST, NOBEL LAUREATE, GERMAN, JEW (2004).

> conclude the German claims of Allied first use are questionable at best]. The most one can say about gas and smoke is that by the eve of the war military awareness of chemical had increased to the extent that some soldiers were willing to consider them and a very few, with a more innovating turn of mind, were even experimenting with various compounds. The substances used with the exception of phosgene, were not toxic. There were no military stocks of gases, nor of gas shell, save for very limited supplies tear gas grenades and cartridges in French hands.[137]

The military reaction was mixed on both sides. The German commander of the Army Corps at Ypres said in his memoires:

> I must confess that the commission for poisoning the enemy, just as one poisons rats, struck me as it must any straightforward soldier; it was repulsive to me. If, however, the poison gas were to result in the fall of Ypres, we would win a victory that might decide the entire campaign. In view of this worthy goal, all personal reservations had to be silent . . . . War is necessity and knows no exception.[138]

It is important here to note that many of the weapons used by both sides were not gases per se. Rather, they often involved particles of toxic materials disbursed in smokes and or by shell fragmentation.[139] Thus, Haber points out:

> [T]he particular anxiety caused by the German Blue Cross shells [was] with their arsenical filling. Whilst the German method of disbursing the active agent by high explosive fragmentation ensured that it would have little toxic effect, *there were occasions when particulates capable of penetrating the SBR*[140] *were produced* . . . . Blue Cross shells were a potential

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137. HABER, *supra* note 113, at 19–21.

138. TUCKER, *supra* at note 42, at 13, 392 (quoting BERTHOLD VON DEIMLING, AUS DER ALTEN IN DIE NEUE ZEIT 201 (Berlin, 1930)); *see also* STÉPHANE AUDOIN-ROUZEAU & ANNETTE BECKER, 14-18: UNDERSTANDING THE GREAT WAR 155 (2000).

139. As the *Military Law Review* points out:

> The gas shell used in 1915 . . . evolved from an earlier model which was first used in October 1914. At that time double salts of dionialine was added to the powder of the projectile. *The irritant would hover as dust in the air* after the shell burst. It was not very intense. Nevertheless, an unnoticed important first step had been taken toward gas warfare.

Joseph Kelly, *Gas Warfare in International Law*, 9 MIL. L. REV. 1, 7 (1960) (emphasis added).

140. The small box respirator ("SBR") was the last World War I version of the British protective mask. *See* JONES, *supra* note 131, at 31–32.

> danger, and the *Allied experts were concerned that the Germans might introduce arsenical smoke generators*; soldiers would thereby be rendered so debilitated that they couldn't fight any more.[141]

Finally, Haber again raises the issue of the Hague conventions:

> The agreements were negotiated and signed at a time when statesmen were supposed to have moral standards, and it was generally expected that such declarations of principles . . . would be respected by all belligerents in a future war. The events of August-September 1914 [German's invasion of Belgium] dented these illusions, the German [use] of chlorine the following spring shattered them, and set a precedent [contemporary language] still conveys the emotional shock. Conan Doyle wrote that the Germans had "sold their souls as soldiers" . . . it was only a short step to legitimize the use of gas at all times, and not solely in retaliation against the enemy's first use. . . . The German post-war attitude was that the Hague Conventions still applied, indeed they had not been breached in 1915–18. [Furthermore] in any case the Germans had not been guilty of a precedent for it was the French who had first used bullets and shells with toxic materials.[142]

Haber concludes that the practical effect of these attitudes was that international agreements to abandon poison gas would be meaningless unless accompanied by peacetime verification and wartime sanctions against transgressors.[143] The Allies, as victors, and eventually as treaty negotiators, seemed to disagree with that conclusion, for in the postbellum period they produced a number of treaties designed to prevent future uses of poisonous and asphyxiating gases and similar "processes" or "devices."[144] What they meant by those words is a key to analysis in this Article.

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141. HABER, *supra* note 113, at 256 (emphasis added).

142. *Id.* at 291.

143. *Id.*

144. As will be discussed below, the use of the words "processes" as opposed to the word "devices" is a key part of the Author's analysis leading to his conclusion that it was the intent of the drafters from 1919 to 1925 to ban something more than just toxic and asphyxiating gases, and that they specifically knew and predicted that additional new types of weapons would mimic but not take the same physical form as the existing chemical weapons. *See* discussion *infra* Part II.A.1.d.i.

d. Post-War Efforts to Control Chemical Warfare

The fear of chemical war in general, while initially pointed at Germany, was, in fact, by the end of the decade, directed generally at all industrialized powers. In 1928, a French author predicted that:

> Everyone foresees this new form of plague will rapidly progress. No one doubts that if war explodes again each side will use chemical weapons which will play the central role; everything else will be an accessory. These weapons, studied in secret and prepared in the world's laboratories, will become progressively more deadly.[145]

Bernauer summarizes the post-war situation:

> Increasing public awareness of the horrors of chemical warfare stimulated further efforts aimed at a ban on [chemical weapons]. The Treaty of Versailles prohibited Germany, the State which had used chemical weapons first in World War I, from manufacturing or importing poisonous gases. Other peace treaties of 1919-20 contained similar provisions. The Treaty of Washington which was to limit the use of submarines, but never entered into force, included limitations on the use of noxious gases . . . . In May, 1925, a conference on methods to control the international arms trade was convened in Geneva within the framework of the League of Nations. At this conference the United States initially proposed a prohibition of the export of chemical weapons. Many states objected to such a ban . . . . The United States therefore proposed to conclude an agreement banning the use of chemical weapons in war.[146] As a result of a Polish initiative, biological means of warfare were added. On 17 June 1925 the "Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare" was adopted. It was,

145. HENRI LEWITA, AUTOUR DE LA GUERRE CHIMIQUE 39 (1928) (Fr.) (author's translation).

146. The use of the word "therefore" may not be entirely accurate. As discussed *infra* in Part II.A.1.d.iii, the reasons for the U.S. proposal of a ban on use of chemical weapons seemed to lie in domestic politics rather than within the conference negotiations.

> by and large, modeled after Article 5 of the Washington Treaty of 1922.[147]

The initial steps to reach that protocol began, as Bernauer notes, with the drafting in 1919 of the Treaty of Versailles[148] which ended the war between Germany and the Allies, and continued with the other separate treaties ending the war with other members of the Central Powers.[149]

i. The Treaties Ending the War

The language most often cited as a starting point for the post-World War I legal treatment of chemical weapons is article 171 of the Treaty of Versailles: "The use of asphyxiating, poisonous or other gases and all analogous liquids, materials or devices being prohibited, their manufacture and importation are strictly forbidden in Germany. The same applies to materials specially intended for the manufacture, storage and use of the said products or devices."[150] The French version of article 171 reads: "*L'emploi de gaz asphyxiants, toxiques ou similaires, ainsi que de tous les liquides, matières ou procédés analogues étaient prohibés, la fabrication et l'importation en sont rigoureusement interdites en Allemagne. Il en est de même du matériel spécialement destiné à la fabrication, à la conservation ou à l'usage desdits produits ou procédés.*"[151]

The broad language of the Allied drafters at Versailles was not unintentional. Among the "main principles which guided the Allies in framing the Military Terms" of the Treaty was to "avoid all ambiguity, which might hereafter give Germany a pretext for evading her obligations."[152] Verwey points out that, in fact, the original text in article 5 of the pre-Versailles draft, "Concerning a

147. THOMAS BERNAUER, THE PROJECTED CHEMICAL WEAPONS CONVENTION: A GUIDE TO NEGOTIATIONS IN THE CONFERENCE ON DISARMAMENT 11–12 (1990) (citations omitted).

148. Treaty of Peace between the Allied and Associated Powers and Germany, June 28, 1919, S. DOC. NO. 66-49 (1919), 225 Consol. T.S. 188 [hereinafter Treaty of Versailles].

149. BERNAUER, *supra* note 147, at 11–12. As will be discussed below, those separate treaties contained somewhat differing language in their articles relating to bans on possession of chemical weapons..

150. Treaty of Versailles, *supra* note 148, art. 171.

151. *Id.* (French text).

152. 2 HISTORY OF THE PEACE CONFERENCE OF PARIS: THE SETTLEMENT WITH GERMANY 127 (H. Temperley ed., 1920).

Definitive Military Status of Germany," provided: "Production or use of asphyxiating, poisonous or similar gases, any liquid, any material and any similar device capable of use in war are forbidden."[153] "There is no doubt," says Verwey, "that this formulation was intended to mean 'forbidden in and to Germany',[154] since the Allied Powers certainly did not intend to give up the production of chemical weapons themselves."[155] Later, he notes, the provision shows up as article 13 of the "Naval, Military and Air Conditions of Peace" where the Versailles article 171 language appeared.[156] Verwey says that "[t]here is no indication . . . in the records that the phrase 'being prohibited' was inserted on purpose," and that the discussions rather point to the opposite conclusion; that the entire article was related to Germany's obligations alone . . . ."[157] Verwey's conclusion that the gas articles of Versailles and other treaties were aimed at the Central Powers alone seems to be the correct interpretation,[158] although its significance was, for present

153. WIL VERWEY, RIOT CONTROL AGENTS AND HERBICIDES IN WAR 262 (1977).

154. In their official response to protests of the treaty's harshness from the German delegation at Versailles, the Allies stated that Germany was "the first to use poisonous gas notwithstanding the appalling suffering it entailed" and that, *inter alia*, was "why Germany must submit for a few years to certain special disabilities and arrangements." Georges Clemenceau, *Allied Reply to German Delegates' Protest Against Proposed Peace Terms at the Paris Peace Conference*, TIMES (London), June 17, 1919, at 1, *reprinted in* 13 AM J. INT'L L. 545–52 (1919).

155. VERWAY, *supra* note 153, at 262. Harold Vaughn noted contemporaneously that:

> After what became routine statements in favor of the idea that all nations should now disarm, the delegates did nothing except to strip the defeated powers of their remaining military establishments, and then plan how to keep them in a state of permanent military inferiority. Wilson's fourth point called for the reduction of national armaments 'to the lowest point consistent with domestic safety,' but it was applied only to Germany.

HAROLD VAUGHN, VERSAILLES TREATY, 1919; GERMANY'S FORMAL SURRENDER AT THE END OF THE GREAT WAR 36 (Franklin Watts 1975).

156. VERWAY, *supra* note 153, at 262

157. *Id.* Verwey adds that this impression is supported by the insertion of flamethrowers into the concomitant articles of the peace treaties with Austria (article 135) and Hungry (article 119), noting "[i]t could hardly be [argued] that *anno* in 1919 flamethrowers were considered prohibited by specific customary international law." *Id.*

158. Adolf-Boelling Overweg in 1937 thought article 171 was "eine Fiktion ohne praktische Bedeutung." That is, "a fiction without practical meaning." ADOLF-BOELLING OVERWEG, DIE CHEMISCHE WAFFE UND DAS VOLKERRECHT 69 (1937) (F.R.G.) (author's translation). Overweg analyzes the background history of article 171 in considerable depth, but makes no mention of textual discrepancies regarding "devices" between the French and English versions. *See id.* at 64–72.

purposes, mooted by subsequent developments in 1922 and 1925, when the later treaties incorporated and ratified the relevant language.[159]

What is important for this Article, however, is the Versailles ban on devices,[160] which was, indeed, present in the drafts from the very beginning.[161] It is interesting to note that the various treaties ending the war with the Central Powers were not exactly the same regarding banned chemical weapons. As noted above, article 171 of Versailles refers to "analogous liquids, materials or devices."[162] The Treaty of St. Germaine-en-Laye,[163] which ended

159. The conclusion seems logical, since everything in the drafting process of the post-war treaties was designed to prevent the losing parties from ever again presenting a military threat. *See* BROWN, *supra* note 119, at 52. He notes that:

> There was . . . a significant difference between the first draft prepared by the Foch Committee of the Supreme War Council on March 3, 1919, and the final article. The draft article was blunt . . . .
>
> > "Production or use of asphyxiating, poisonous or similar gases, any liquid, any material and any similar device capable of use in war are forbidden."
>
> The draft article was accepted without comment on March 6 and March 10, 1919. The regulations were redrafted to reflect substantive comments on other articles between March 10 and March 17. In the redrafted regulations . . . Article 5 became Article 13, and the wording was changed to that of the final Article 171. *There is no indication that the change in wording was realized to be other than procedural.*

Id. at 52–53 n.1. (emphasis added) (citations omitted); *see also* A HISTORY OF THE PEACE CONFERENCE OF PARIS, *supra* note 152, at 134 ("Whatever we may do to reduce the strength of the German Army, and to prevent the military training of the people, there are, and will for some time continue to be, in Germany several millions of men trained and inured to war. Similarly, there are large numbers of regimental and staff officers, with ample war experience. These are accomplished facts, which we are powerless to alter. On the other hand, *it is quite possible to deprive Germany of the arms, ammunition, and material necessary for the equipment of a great army.*" (emphasis added)).

160. "Device" is currently defined in England as "A thing designed for a particular function or adapted for a purpose; an invention. A contrivance, *esp* a (simple) mechanical contrivance . . . . An explosive contrivance, *esp.* a nuclear bomb" 1 SHORTER OXFORD ENGLISH DICTIONARY 667 (6th ed. 2007). A more contemporaneous English definition is not fundamentally different. "Something invented and constructed for a special purpose; an instrument or combination of instrumentalities formed with intelligence and design; contrivance; as, a mechanical *device* for controlling vibration." A STANDARD DICTIONARY OF THE ENGLISH LANGUAGE 502 (London, Funk & Wagnalls 1895).

161. VERWEY, *supra* note 153, at 262.

162. Treaty of Versaille, *supra* note 148, art. 171.

163. Treaty of Peace between the Allied and Associated Powers and Austria, Sept. 10, 1919, S. DOC. NO. 66-92 (1919), 226 Consol. T.S. 8 [hereinafter Treaty of St. Germaine-en-Laye].

the war with Austria, added flamethrowers[164] to the mix, but kept the reference to devices: "The use of flamethrowers, asphyxiating, poisonous or other gases, and all similar liquids, materials or devices being prohibited . . . ."[165] Apparently, there "devices" still modifies "gases" since the language is unchanged from Versailles except for the addition of flamethrowers.[166]

There has been considerable discussion about the meaning of the word "similares" modifying asphyxiating and toxic gases in the French version, versus the word "analogous" in the English text.[167] During the Vietnam conflict, the United States took the

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164. The modern flamethrower was designed by Berlin engineer Richard Fiedler and the German Army tested two models in 1901. Michael Dewar, *The First Flame Attacks*, *in* TANKS & WEAPONS OF WORLD WAR I, 47–48 (Bernard Fitzsimons ed., 1973). The smaller version, more commonly used, was gas pressurized, light enough to be man-portable and had a range of approximately twenty yards. *Id.* The larger version had a forty-yard range. *Id.* The weapon was used as early as October, 1914, but its first major use was at Hooge in July, 1915. *Id.* Other nations on both sides quickly adopted the weapon, which was used extensively in World War II, and the Korean and Vietnam Wars. STEPHEN BULL, ENCYCLOPEDIA OF MILITARY TECHNOLOGY AND INNOVATION 88–89 (2004). The United States unilaterally removed flamethrowers, but not flame weapons, from its arsenal in 1978. *See* Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects, Protocol III arts. 1(a), 2(1), Oct. 10, 1980, S. TREATY DOC. NO. 103-25 (1981), 1342 U.N.T.S. 137 [hereinafter Conventional Weapons Convention] (defining flamethrowers as incendiary weapons and limiting, but not prohibiting, their use). The subsequent use of flamethrowers, taken together with the Convention on Conventional Weapons language, makes it clear that states have not viewed that weapon as a "device" covered by the 1925 Protocol or subsequent treaties.

165. Treaty of St. Germaine-en-Laye, *supra* note 163, art. 135.

166. Immediately before presentation of the draft Treaty of Versailles to Germany on May 10, 1919, the Council of Four (Lloyd George of England, Vittorio Emanuele Orlando of Italy, Georges Clemenceau of France, and Woodrow Wilson of the United States) decided to next complete the treaty with Austria-Hungary and ordered its Central Secretariat to prepare a draft. 4 A HISTORY OF THE PEACE CONFERENCE OF PARIS: THE SETTLEMENT WITH GERMANY 141–42 (H. Temperley ed., 1920). The military clauses were drafted by the British section which followed the general arm limitations imposed on Germany. *Id.* at 143. The council's military representatives adopted the British draft, which followed the Versailles language precisely "except that the word Flammenwerfer [flamethrowers] was added in the first line of Article 135." *Id.* at 150. Thus, the modification of "gases" by "devices" not only preceded the additional word, there was apparently no intent to do anything other than add another banned weapon to a convenient clause.

167. A General Conference for the Reduction and Limitation of Armaments under the sponsorship of the League of Nations and attended by League members plus the United States and the Union of Soviet Socialist Republics ("U.S.S.R.") took place in Geneva from 1932 to 1934. *See* Mount Holyoke College, Department of International Relations, Disarmament Discussions 1932-34, http://www.mtholyoke.edu/acad/intrel/WorldWar2/disarm.htm (last visited Apr. 3, 2010). In the preparatory work for that

position that the French text excluded tear gases because they were not similar to choking or poisonous gases and others disagreed because they thought tear gas "analogous."[168]

There has not, however, been a similar discussion of whether there is a distinction between "analogous devices" and "*procédés analogues*," in the second clause of the first sentence of article 171.[169] The word "devices" in the specific sense of related equipment or application is better articulated with "*appareil*" (apparatus) or "*dispositif*" (device).[170] While "*procédé*" may be translated as "processes" in general circumstances, for example *technique de fabrication* (manufacturing technique), it also carries a more specific meaning.[171] "*Procédé*" has the strong connotation of bringing about a similar result or end-state. One common synonym for "*procédé*" appears to be "*conduite*" (behavior).[172] Indeed, a subtext of artificially obtaining an analogous result is inherent in the word. It is therefore significant that the

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conference, the British Foreign Office produced a Memorandum on Chemical Warfare which pointed out "a serious ambiguity" regarding the translation of the word "similaires" as "other." *See Minutes of the Sixth Session (Second Part) of the Preparatory Commission for the Disarmament Conference, Minutes of Twentieth Meeting, December 2, 1930,* League of Nations Series No. 9, 311 (1931), *available at* http://digital.library.northwestern.edu/league/le00307h.pdf. The U.K. memorandum proposed French and English language drafts which substituted the English word "similar" for "other." *Id.* More interesting here, the U.K. draft also substituted, without comment, the word "processes" for "devices" as a translation for "procédés." *Id.* The conference adopted the U.K. draft, but, of course, it never produced even a final draft treaty before it dissolved in light of events which were to lead to the Second World War.

168. *See infra* note 222.

169. Treaty of Versailles, *supra* note 148, art. 171; *see, e.g.*, Natalino Ronzitti, *Le Desarmement Chimique et le Protocole de Geneve de 1925* [*Chemical Disarmament and the Geneva Protocol of 1925*], 35 ANNUAIRE FRANCAIS DE DOIT INTERNATIONAL 149 (1989) (Fr.) (discussing at length the "similares" versus "other" debate, but never mentions any conflict between "analogous devices" and "*procédés analogues*").

170. *See id.*

171. Relevant definitions from the Larousse Dictionary state:

- *Manière d'agir, de se comporter : Ce sont là des procédés malhonnêtes.* [Manner of acting or behavior. They are proceeding dishonestly.]
- *Manière de s'y prendre, méthode pratique pour faire quelque chose : Un nouveau procédé de fabrication.* [Means to an end, practical method to do something: A new manufacturing process.]
- *Recette toute faite visant à obtenir artificiellement un résultat avec peu de moyens.* [Recipe for artificially obtaining a result with the least means.]

LAROUSSE FRENCH-ENGLISH, ENGLISH-FRENCH DICTIONARY (New ed. 2007), *available at* http://www.larousse.fr/ (author's translations).

172. *See id.*

translation "processes" was used elsewhere,[173] but rejected for "devices." Thus, the French version provides some additional evidence that the intention was to include entities with similar or analogous effects, outcomes, or behaviors, rather than simply devices associated with distribution of otherwise banned substances.[174]

The situation, of course, gets more complicated. In the Treaty of Neuilly-sur-Seine with Bulgaria, flamethrowers are kept in the relevant article 82, but the word "processes" is substituted for "devices."[175] Does that substitution indicate any intent to change the nature of the treaty? It is difficult to support that conclusion, because six months later when a treaty is signed with Hungary, the language veers back to "similar devices."[176] Later in 1920, the preliminary treaty with Turkey again contained the "similar processes" phrase,[177] but, to complicate the puzzle even

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173. *See infra* notes 175, 177 and accompanying text (using "processes" in other treaties ending World War I).

174. Interestingly, Josef Kunz, in *Gaskrieg und Völkerrecht*, says:

> *Durch Versailles, Artikel 171, wird Deutschland die Herstellung und Einfuhr von erstickenden, giftigen und ähnlichen Gasen, von allen entsprechenden Flüssigkeiten, Stoffen oder Verfahrensarten sowie von Gebrauch der genannten Erzeugnisse oder Verfahrensarten sowie von allem Material das eigens für die Herstellung, Aufbewahrung oder den Gebrauch der genannten Erzeugnisse oder Verfahrensarten bestimmt ist streng untersagt und zwar im Hinblick daruf, dass dieser Gebrauch verboten ist.* [In the view of the fact that its use is forbidden, by Versailles, article 171, Germany is strictly forbidden from the production and importation of suffocating, poisonous and similar gases, of all corresponding liquids, materials or types of procedure, as well as the products or types of procedure mentioned as well as by all material particularly intended for the production, storage or the use of the products or kinds of procedure mentioned.]

JOSEF KUNZ, GASKRIEG UND VÖLKERRECHT 37 (1927) (author's translation). Kunz uses the phrase "entsprechenden . . . Verfahrensarten" (corresponding type of procedure) which effectively translates the French phrase "*procédés analogues*," but which in the context must mean something else, since as used, a "type of procedure" could not in itself be produced, stored, or imported. *Id.* It is telling that in the next sentence, he concludes that article 171 is "*identisch sind*" (identical with) the parallel articles of the other treaties ending World War I. *Id.*

175. Treaty of Peace between the Principal Allied and Associated Powers and Bulgaria art. 82., Nov. 27, 1919, S. DOC. NO. 67-7, at 47–162 (1921), 226 Consol. T.S. 334.

176. Treaty of Peace between the Principal Allied and Associated Powers and Hungary art. 119, June 4, 1920, S. DOC. NO. 67-7, at 163–319 (1921), 6 L.N.T.S. 187.

177. Treaty of Peace between the Principal Allied and Associated Powers and Turkey art. 176, *opened for signature* Aug. 10, 1920, S. DOC. NO. 67-7, at 320–448 (1921), *reprinted in* 15 AM. J. INT'L L. 179 (Supp. 1921).

further, the entire article relating to chemical weapons was deleted when the final version of the treaty was signed in 1923.[178]

In short, every treaty except Versailles bans flamethrowers, and every treaty except Versailles uses the word "similar" while Versailles utilizes "analogous." However, the first, second, and fourth treaties use "devices" while the operable word in the third and fifth is "processes." How is it possible to know what the language was intended to mean? Interestingly, article 172 of the Treaty of Versailles required that Germany "disclose . . . the nature and mode of manufacture of all explosives, toxic substances or other *like chemical preparations* used by them in the war or prepared by them for the purpose of being so used . . . ."[179] By contrast, it did not require the disclosure of similar or analogous devices or processes.[180] Whether or not it is even possible to deduce from this dissimilar language that the drafters had any particular intent, it is at least clear that they were aware that language could vary in many ways, and seemed to choose the broadest possible language in the ban contained in article 171 and its parallels in other treaties.[181]

Fries' discussion of methodology current in 1921 is enlightening:

> [W]e must expect that new gases, new methods of turning them loose, and new tactical uses will be developed . . . . Some of the poisonous gases are so powerful in minute quantities and evaporate so slowly that their liberation does not . . . cause a cloud. Consequently, we have gases that cannot be seen. Others form clouds by themselves, such, for instance, as the toxic smoke candle, where the solid is driven off by heating . . . . It would be idle to attempt to enumerate the ways and means by which chemicals will be used in the future. In fact, one could hardly conceive of a situation where gas or smoke will not be employed, *for these materials may be liquids or solids that either automatically, upon exposure to the air, turn into gas, or which are pulverized by high explosive, or driven off by heat.* This varied character of the materials

178. *See generally* Treaty of Peace with Turkey, July 24, 1923, 28 L.N.T.S. 11.

179. Treaty of Versailles, *supra* note 148, art. 172 (emphasis added).

180. *Id.*

181. For discussion of other possible treaty language, see Herbert F. Manisty, *The Use of Poison Gas in War,* 9 TRANSACTIONS GROTIUS SOC'Y 17, 17–28 (1923).

> enables them to be used in every sort of artillery shell, bomb or other container carried to the field of battle.[182]

It is worth noting that Fries' arguments about the technical legality of German conduct were still being made as late as 1942, when a law review note was published stating that "[b]rutal as she otherwise was, *Germany did not violate international law by the use of chlorine on April 22, 1915*."[183] Of course, the thesis of that note is somewhat impacted by its concluding sentence: "There is hardly a field of peaceful human endeavor which does not owe a debt to the Chemical Warfare Service."[184] Of particular interest here, though, is the author's argument that:

> The Germans had [in 1914] developed a [lacriminatory] gas-filled artillery shell by modifying a 10.5 cm. shrapnel . . . . This gas projectile was not within the interdiction of Declaration II [of the Hague Convention], for diffusion of asphyxiating or deleterious gas was not its sole object. Its main purpose was that of shrapnel against personnel. *Further, it disbursed a fine dust of solid and not a gas.*[185]

Indeed, as Fries points out, one of the areas where Germany did early work was in arsenic derivatives.[186] The most commonly used German arsenical was diphenylchloroarsine ("Blue Cross"), which was "a white solid, which readily penetrated the [gas mask] canister and caused sneezing."[187] This substance

> was used in shells carrying a high bursting charge. The explosion of the shell scattered the Sneezing Gas in the form of a very fine cloud of particles. While the charcoal of the mask will remove most poisonous gases, it has no protective power against clouds or mists. The Sneezing Gas passed through the best canister, and through its peculiar physiological effect caused great discomfort to the men and

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182. FRIES & WEST, *supra* note 120, at 436–37 (emphasis added.).

183. Cyrus Bernstein, Note, *The Law of Chemical Warfare, War Law Notes: The Law of Chemical Warfare*, 10 GEO. WASH. L. REV. 889, 908 (1942) (emphasis added).

184. *Id.* at 915.

185. *Id.* at 907 (emphasis in original omitted) (second emphasis added).

186. FRIES & WEST, *supra* note 120, at 180.

187. *Id.* at 181; *see also* James F. Norris, *The Manufacture of War Gases in Germany*, 11 J. INDUS. & ENGINEERING CHEMISTRY 817, 824–25 (1919). Germany used various colored markings for identifying different gas types. *See* SIMON JONES, WORLD WAR GAS WARFARE TACTICS AND EQUIPMENT 50 (2007) ("They simplified the classification to Green, Blue and Yellow Cross: green for lung irritant; blue for sensory irritant, i.e. *solids to penetrate respirator filters*; and yellow for mustard gas." (emphasis added)).

> numerous casualties through forcing the men to remove their masks.[188]

The British experimented with this substance as well.[189]

Much of the point of the discussion above is that professional soldiers and diplomats knew very well at the end of World War I that poisonous, asphyxiating, and related weapons came in forms other than gas;[190] signatory states might be anxious to avoid the technical strictures of any treaty;[191] and they were willing to try to write a ban which took into account all possible forms of poisonous, asphyxiating and related weapons foreseeable in the future.[192]

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188. Clarence J. West, *The Chemical Warfare Service*, *in* THE NEW WORLD OF SCIENCE: ITS DEVELOPMENT DURING THE WAR 148, 153, (Robert M. Yerkes ed., 1920); *see also* Nuclear Threat Initiative, Diphenylchloroarsine, http://nti.org/e_research/profiles/nk/chemical/1094.html (last visited Apr. 3, 2010) ("Military doctrine in World War I . . . counted on its being able to force soldiers to remove their protective masks, and thus becoming vulnerable to it or other chemical agents.").

189. In 1918, the British experimented with burning granules from a German Blue Cross shell and quickly realized its ability to penetrate their respirator. Inspired by those Blue Cross experiments, they "perfected the thermogenerator . . . which produced an arsenic smoke capable of penetrating all known respirators apart from their own. As well as causing intense pain in the sinuses it also created temporary but intense feelings of psychological misery." JONES, *supra* note 187, at 57–59. Thermogenerator grenades, adapted as aerial bombs, became the first air dropped chemical weapons when used by the Royal Air Force against Bolshevik forces near Archangel in 1919. *Id.* at 57; *see also* MICHAEL KETTLE, CHURCHILL AND THE ARCHANGEL FIASCO 316 (1992) ("On April 16 [1919], Churchill's Secretary received a letter . . . from Sir Keith Price [an explosives and munitions expert] which stated, 'If there is going to be a White Sea campaign, do not let the powers that be overlook the new gas generators. I really believe they are the most deadly weapon which has yet been produced . . . . The D.M. generator knocks people out for say 48 hours but does not kill them, the D.A. kills alright; which is the right medicine for the Bolshevist."). "D.A." was, in fact, the British code name for diphenylchloroarsine, the chemical in Blue Cross. David B. Kirkwood, *Non-Lethal Weapons*, *in* MILITARY OPERATIONS OTHER THAN WAR 4 (1996). "D.M.A." was the code name for diphenylamine chlorasine. *Id.* Sir Keith Price appears to have been confused about the names and qualities of DA and DM. KETTLE, *supra*, at 316.

190. *See supra* note 182–189.

191. *See supra* notes 132–44; *see also, e.g.*, DENNIS MYERS ET AL., THE TREATY OF VERSAILLES AND AFTER: ANNOTATIONS OF THE TEXT OF THE TREATY 44–54 (1968) (noting the German and U.S. commentators' arguments about the technical legality of Germany's deployment of chlorine gas from cylinders in 1915).

192. *See supra* note 179. It is worth noting that in 1940 the U.S. Army was actively concerned with defenses against irritant smoke which it defined as "a chemical agent which can be disseminated as extremely small solid or liquid particles in air, and . . . causes intolerable sneezing, coughing, lacrimation, or headache, followed by nausea and temporary physical disability when breathed in very low concentrations." CHEMICAL WARFARE SERV., U.S. ARMY, DEFENSE AGAINST CHEMICAL ATTACK 4 (1940). The Army also recognized that there was a distinction between irritant gas candles and toxic smoke

One startlingly applicable statement regarding such weapons was made by ex-Major Victor Lefebure, who had served from November 1917 through the end of the war as the British liaison officer with the French Army for chemical warfare.[193] Lefebure later authored *The Riddle of the Rhine* about the German chemical industry and its ties to gas warfare.[194] In 1921 he was invited to address the Grotius Society as part of its *Problems of Peace and War* series.[195] Lefebure began his address by arguing that "chemical warfare is far too potent, decisive, flexible, secret, and generally dangerous to be left unharnessed in a world which pretends to disarm."[196] He devoted much of his address to how new chemical weapons are developed through research, development and manufacturing stages, and he proposed designing applicable treaty controls at all three stages.[197] His conclusion, however, not only resonates after almost ninety years, but it is direct evidence of how broadly weapons-related scientists and soldiers were thinking contemporaneously with the drafting of the treaties discussed here:

> I should point out that these remarks are not limited to chemical warfare, but they apply to the development of all new weapons. *Taking a long-distance view, no distinction should be made. If sub-atomic forces can eventually be harnessed for war they must be subjected to the same control and attempts at suppression during their development stages.* Chemical warfare happens to be the present problem of the maximum practical importance in this field.[198]

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candles. *See* U.S. DEP'T OF WAR, TECHNICAL MANUAL: GERMAN-ENGLISH MILITARY DICTIONARY 506 (1944) (defining "*giftnebelkerze*" as an "irritant gas candle" and "*giftrauchkerze*" as a "toxic-smoke candle").

193. Obituary, *Victor Lefebure*, TIMES (London), 1948, at 394.

194. VICTOR LEFEBURE, THE RIDDLE OF THE RHINE (1921).

195. *See* Victor Lefebure, *Chemical Warfare: The Possibility of its Control*, 7 TRANSACTIONS GROTIUS SOC'Y 153 (1921).

196. *Id.* at 157.

197. *See id.*

198. LEFEBURE, *supra* note 194, at 12 (emphasis added). There is a great deal of useful historical evidence in this area. Particularly useful is the *Report of the Committee Appointed to Consider the Question of Chemical and Bacteriological Warfare*, League of Nations Official Journal Special Supp. No. 26, 121 (1924). Regarding chemical warfare the committee notes:

> The term "gas" as used in connection with warfare does not correspond to the scientific definition of gases. In reality it includes not only gases but solid or liquid substances which are reduced to powder or spray in the air . . . . Such substances are by no means rare. The majority are common materials,

Thus it seems clear from the evidence that the Versailles Treaty drafters knew the poisonous and asphyxiating "gases" of the Great War were often something other than gas in the technical sense of physicists,[199] and that there was an attempt at inclusion rather than exclusion of anything which might produce analogous results. It does not assist the researcher attempting to divine intent that many of the negotiations were kept secret and the records ostensibly destroyed.[200] Once again, however, there is some other guidance. In a 1922 analysis of the "Secret Minutes of the Paris Peace Conference" the *New York Times* revealed that:

> Two things were at once assumed by the conference and brushed aside, as the most vital problems often are, practically without discussion: First, that Germany should be utterly disarmed, so far as military uses were concerned, of airplanes, poison gas, submarines, tanks, etc. Every one [sic] agreed to that. Second, no one at Paris considered for a moment an immediate general reduction of armament in these new Instrumentalities which should apply to the allies as well as to the enemy States . . . . They were all agreed on an absolute prohibition of the military use of gases . . . . But the other Allies wished to go much further. They wished to

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ordinarily manufactured and employed in large quantities for peace-time requirements, so that "*there is very little difference between the manufacture of pharmaceutical products and that of injurious substances used in war.*"

Id. (emphasis added); *cf.* W. Eysinga, *La Guerre Chimique et le Mouvement pour sa Repression* [*Chemical War and the Movement for Its Repression*], *in* 16 ACADEMIE DE DOIT INTERNATIONAL 335 (Leyden, 1972) (1927) (Fr.).

199. *See* ASTM INTERNATIONAL, ASTM DICTIONARY OF ENGINEERING SCIENCE & TECHNOLOGY 269 (10th ed. 2005) (defining gas as "the state of matter in which the molecules are practically unrestricted by intermolecular forces so that the molecules are free to occupy all space within an enclosure" and particulate as "a general term used to describe a finely divided solid of organic or inorganic matter"). ASTM International, originally known as the American Society for Testing and Materials, is a voluntary standards development organization and source for technical standards. *See* About ASTM International, http://www.astm.org/ABOUT/aboutASTM.html (last visited Apr. 3, 2010). Importantly, this group defines "smoke" as "small gas-borne particles resulting from incomplete combustion." *Id.* at 433. That understanding of the meaning of "smoke" really has not changed since W.F.M. Goss noted in 1916, that the properties of smoke were defined as "gaseous and solid products of combustion, visible and invisible," and that smoke regarded as possessing both solid and gaseous constituents. W.F.M. Goss, *Smoke as a Source of Atmospheric Pollution*, 181 J. FRANKLIN INST. 305, 320 (1916).

200. *See*, MYERS ET AL., *supra* note 191, at iii (noting that "negotiations which resulted in the language of the treaty taking its final form have not been recorded, for it was not the intention of the makers but the action of the parties to the treaty which was to be ascertained. It was seldom found to be pertinent to discuss interpretations of the language finally adopted").

> compel the German Government to disclose her chemical processes and secrets . . . . [Secretary of State Robert Lansing expressed President Wilson's view that] "*since the use of asphyxiating, poisonous or other gases and all analogous matters or devices had been prohibited*,[201] including their manufacture or importation, he thought that was sufficient safeguard . . . ." *It became crystal clear as these discussions developed that everything depended upon point of view . . . . If men looked upon inventions and scientific appliances only from the point of view of war, then everything became dangerous; there must be an attempt to corner every contingency with a prohibition and often a perpetual prohibition at that*; with a final reducto ad absurdum in trying to penetrate the secrets of men's minds. . . . Prohibitions were not enough [Wilson argued, what was needed also was a League of Nations].[202]

In any case, it was the "analogous devices" language of Versailles that was adopted first by the Washington Naval Conference in 1922,[203] and then in the 1925 Geneva Gas Protocol.[204] The history behind these words indicates, however, that the drafters specifically chose "analogous devices" over "similar processes," that they were determined to prevent Germany from again arguing that such weapons were outside the scope of treaty language, *and* that they were very well aware that smoke and particulate matter could be produced and used as a lethal weapon of war to disburse asphyxiating or toxic chemicals.

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201. Note that in the French text, Lansing is quoted as saying "*Il s'agit d'obliger les Allemandes a faire connaitre les secrets de fabrication de certains produits employees pour des procedes de guerre contraires au doit des gens. Ceci vise essentiallement* les gaz et autres produits chimiques. [This is to oblige Germany to disclose the secrets of making certain products employed for illegal warfare. Essentially, it is aimed at *gases and other chemical products*]" Paul Mantoux, Official Interpreter, 1 LES DELIBERATIONS DE CONSEIL DES QUATRE 24 MARCH–28 JUNE, 1919 267 (Editions de Centre National de la Recherche Scientifque 1955) (emphasis added) (author's translation). While the English language notes of what Lansing actually said are probably most authentic, it is interesting that the official French interpreter translated "asphyxiating, poisonous or other gases and all analogous matters or devices had been prohibited" *as les gaz et autres produits chimiques. Id.*

202. Ray Baker, *America and the World Peace*, N.Y. TIMES, Feb. 5, 1922, at 80 (emphasis added).

203. Treaty between the United States of America, the British Empire, France, Italy, and Japan Relative to the Protection of the Lives of Neutrals and Noncombatants at Sea in Time of War and to Prevent the Use in War of Noxious Gases and Chemicals art. V, *opened for signature* Feb. 6, 1922, S. DOC. NO. 67-126, at 886 (1922), 3 Malloy 3116 [hereinafter Washington Submarine Treaty].

204. Geneva Protocol, *supra* note 23.

The decision at Washington in 1922 to use the words "analogous devices"[205] becomes directly relevant to determination whether the CWC covers nanomimics in light of that history.

ii. The Washington Naval Conference

The Washington Naval Conference was a post-war meeting among nine military powers organized by the administration of U.S. President Warren G. Harding for the purpose of arms control and peace in East Asia.[206] The conference produced five significant treaties over the course of three months.[207] A full description of the proceedings at the Washington Conference may be found in a published doctoral thesis by Raymond Buell.[208] Buell notes that a subcommittee was created to specifically address the topic of poisonous gases.[209] The Subcommittee on Poison Gas privately reported on December 8, 1921, that suppressing poison gas was unwise and unworkable,[210] and issued a public report on January 6, 1922, which concluded that "the only limitation practicable is to wholly prohibit the use of gases against cities and other large bodies of noncombatants in the same manner as high explosives may be limited, but that there

205. *See* Washington Submarine Treaty, *supra* note 203, art. V.

206. *See, e.g.*, THE USA IN THE MAKING OF THE USSR: THE WASHINGTON CONFERENCE, 1921–1922, AND 'UNINVITED RUSSIA' 1–3 (2004).

207. *See* Washington Submarine Treaty, *supra* note 203; Treaty between the United States of America, Belgium, the British Empire, China, France, Italy, the Netherlands, and Portugal Relating to the Revision of Chinese Custom Tariff, Feb. 6, 1922, 44 Stat. 2122, 2 Bevans 381; Treaty between the United States of America, Belgium, the British Empire, China, France, Italy, Japan, the Neterlands, and Portugal, Relating to Principles and Policies to be Followed in Matters Concerning China, Feb. 6, 1922, 44 Stat. 2113, 38 L.N.T.S. 277 (commonly referred to as the "Nine-Power Treaty"); Treaty between the United States of America, the British Empire, France, Italy and Japan Agreeing to a limitation of Naval Armament, Feb. 6, 1922, 43 Stat. 1655, 25 L.N.T.S. 202 (commonly referred to as the "Five-Power Treaty"); Treaty between the United States of America, the British Empire, France, and Japan Relating to Their Insular Posessions and Insular Dominions in the Pacific Ocean, Dec. 13, 1921, 43 Stat. 1646, 25 L.N.T.S. 183 (commonly referred to as the "Four-Power Treaty").

208. *See* BUELL, supra note 26.

209. *See id.* at 205. Of the two U.S. members on the subcommittee, one was Brigadier General Amos Fries of the U.S. Army's Chemical Warfare Service. *See* Editorial, *The Suppressed Report*, 17 J. INDUS. & ENGINEERING CHEMISTRY 662, 662 (1925); *see also supra* note 120.

210. *See* Editorial, *supra* note 209, at 662 (reproducing a copy of the report).

could be no limitation on their use against the armed forces of the enemy, ashore or afloat."[211]

The advisory committee to the U.S. delegation, however, reported that poison gas was "abhorrent to civilization . . . a cruel, unfair and improper use of science, [and] demoralizing to 'the better instincts of humanity.'"[212] The advisory committee resolved that "chemical warfare, including the use of gases, whether toxic or nontoxic, should be prohibited by international agreement, and should be classed with such unfair methods of warfare as poisoning wells, introducing germs of disease, and other methods that are abhorrent in modern warfare."[213] The U.S. delegation to the conference rejected the subcommittee's advice and, following a presentation by Secretary of State Charles Evans Hughes, Elihu Root[214] introduced the following resolution on January 6, 1922:[215]

> The use in war of asphyxiating, poisonous *or analogous liquids or other gases and all materials, or devices* having been justly condemned by the general opinion of the civilized world and

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211. BUELL, *supra* note 26, at 208 (quoting the public subcommittee report) (emphasis omitted). A full copy of the report can be found in *Text of the Conference Discussions*, N.Y. TIMES, Jan. 7, 1922, at 3.

212. *Id.* at 206. This committee was appointed by President Harding to represent public opinion and included among its members, General John Pershing, the commander of the American Expeditionary Force in 1917–1918, Herbert Hoover, Samuel Gompers, the Assistant Secretaries of the Navy and of War, and an undersecretary of state. *Id.* n.9. For a list of all the members on the committee, see S. DOC. NO. 67-126, at 785 (1922).

213. *Id.* at 208. The advisory committee reasoned that while use of lethal gas against military opponents might be legal, the potential harm far outweighed any utility. It added that "[t]he committee is of the opinion that the conscience of the American people has been profoundly shocked by the savage use of scientific discoveries for destruction rather than construction," and that whatever the views of technical experts "the committee feels the American representatives would not be doing their duty in expressing the conscience of the American people were they to fail in insisting upon the total abolition of chemical warfare . . . whether against combatant or noncombatant." *Id.* at 386.

214. Former Secretary of War (1899–1904) and Secretary of State (1905–1909) of the United States. *See generally* ELIHU ROOT, ADDRESSES ON INTERNATIONAL SUBJECTS (1916).

215. *See* James, *supra* note 26 ("Mr. Hughes . . . recommended that the report of the Conference Experts' Committee on Poison Gas, which declared it unwise to try to prohibit its use, be set aside, and that the conference act on a report of a subcommittee of the American Advisory Committee, recommending the ban on gas warfare . . . . Mr. Hughes then asked Mr. Root present, on behalf of the American delegation, a resolution for the abolition of gas warfare."). For a summary of the speech delivered by Charles Evans Hughes, see *Text of the Conference Discussions*, *supra* note 202.

> a prohibition of such use having been declared in treaties to which a majority of the civilized world are parties—now, to the end that this prohibition shall be universally accepted as a part of international law, binding alike the conscience and practice of nations, the signatory powers declare their assent to such a prohibition . . . .[216]

Note that the emphasized language differs significantly from the Versailles treaty.[217] Apparently, there was a scrivener's error in the copying of Versailles article 171, or Root erred in its reading. By the time the treaty was signed, however, article 5 of the Washington Submarine Treaty was again congruent with Versailles. It provides:

> The use in war of asphyxiating, poisonous or other gases, and all analogous liquids, materials or devices, having been justly condemned by the general opinion of the civilized world and a prohibition of such use having been declared in treaties to which a majority of the civilized Powers are parties, The Signatory Powers, to the end that this prohibition shall be universally accepted as a part of international law, binding alike the conscience and practice of nations, the signatory powers declare their assent to such a prohibition, agree to be bound thereby as between themselves, and invite all civilized nations to adhere thereto.[218]

Thus, the Versailles language was fully restored in the 1922 Treaty. It was that language which was incorporated into the

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216. S. DOC. NO. 67-126, at 388 (1922) (emphasis added). A full copy of this resolution can also be found in James, *supra* note 26.

217. *Compare* S. DOC. NO. 67-126, at 388 (1922) ("The use in war of asphyxiating, poisonous or analogous liquids or other gases and all materials, or devices having been justly condemned by the general opinion of the civilized world and a prohibition of such use having been declared in treaties . . . ."), *with* Washington SubmarineTreaty, *supra* note 203, art. V ("The use of asphyxiating, poisonous or other gases and all analogous liquids, materials, or devices being prohibited . . . ."). Root told the conference that he was introducing language that "represented the most extraordinary consensus of opinion that one could well find upon any international subject." *See Text of the Conference Discussions*, *supra* note 202. He also indicated that it was borrowed from the Treaty of Versailles, but reflected in many of the treaties that ended the Great War. *See id.* In fact it was only the Versailles language from article 171, and that, of course, was not entirely correct. *See* discussion of variations in treaties ending World War I, *supra* Part II.A.1.d.i.

218. Washington SubmarineTreaty, *supra* note 203, art. V.

Geneva Gas Protocol in 1925, and which in turn was reiterated as binding by the CWC.[219]

iii. The 1925 Geneva Gas Protocol

The Geneva Protocol of 1925 placed the 1922 Washington use ban on the table for all states.[220] The U.S. Senate, however, after the country acted as the prime proponent of a ban, refused to ratify the protocol at that time.[221]

Once again, the 1925 protocol articulated an attempt to ban use in war of chemical weapons, and once again the "devices versus processes"[222] question arises. The language of the protocol tracks the 1922 treaty:

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219. Chemical Weapons Convention, *supra* note 10, pmbl.

220. Geneva Protocol, *supra* note 23. It is worth remembering that the 1922 treaty and the 1925 protocol were drafted in light of a wide effort to end all international armed conflict. *See generally* JAMES SHOTWELL, PLANS AND PROTOCOLS TO END WAR, HISTORICAL OUTLINE AND GUIDE, CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE (1925).

221. *See* HARRIS & PAXMAN, *supra* 120, at 47–48 ("The United States Chemical Warfare Service launched a highly effective lobby . . . . As has often happened since, the fight for chemical weapons was represented as a fight for general military preparedness. Senators joined the CWS campaign, among them the chairman of the Committee on Military Affairs who opened his attack on ratification in the senate debate with a reference to the 1922 Washington Treaty: 'I think it is fair to say that in 1922 there was much of hysteria and much of misinformation concerning chemical warfare.'"). As noted earlier, the United States eventually ratified the 1925 Geneva Gas Protocol in 1975, *supra* note 22, and its binding nature was, of course, reiterated in the CWC. Chemical Weapons Conventions, *supra* note 10, pmbl. It is interesting to note that prior to ratification, the acting director of the U.S. Arms Control and Disarmament Agency testified to the U.S. Senate that:

> This is an area in which a fairly substantial amount of research has now begun to be undertaken and hopefully on the basis of that we would be able to approach this problem on the basis of the 1967 study and not on the basis of a 1925 convention, *no disrespect intended to the drafters of the 1925 convention, they did the best they could with the information available at their disposal*, but the total activity should be looking at the problem of a new situation rather than the same amount of energy expended on the question of whether or not we should ratify the 1925 convention.

Policy Implications of Armament and Disarmament Problems: Hearing Before the Subcomm. on Disarmament of the Comm. on Foreign Relations, 90th Cong. 180 (1967) [hereinafter *1967 S. Hearings on Arms*] (testimony of Sen. Adrian S. Fisher) (emphasis added).

222. As noted above, variations in the language of the treaties, and in the two official text languages of French and English, have in the past been the subject of considerable international discord. *See supra* Part II.A.4.a. These problems carried over into the 1925 protocol. For example, the 1925 Geneva Protocol was long the subject of a dispute over whether it banned "tear" gasses: The English version of the protocol stated that "the use in war of asphyxiating, poisonous or other gases" was prohibited, while the

> Whereas the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids materials or devices, has been justly condemned by the general opinion of the civilized world; and Whereas the prohibition of such use has been declared in Treaties to which the majority of Powers of the world are Parties; and To the end that this prohibition shall be universally accepted as a part of International Law, binding alike the conscience and the practice of nations . . . .[223]

Similarly, the official French version is, in all operative language, precisely the same as the 1922 treaty:

> *Considerant que l'emploi à la guerre de gaz asphyxiants, toxiques ou similaires, ainsi que de tous liquides, matières ou procédés analogues, a été à juste titre condamné par l'opinion générale du monde civilisé, CONSIDERANT que l'interdiction de cet emploi a été formulée dans les traités auxquels sont Parties la plupart des Puissances du monde, DANS LE DESSEIN de faire universellement reconnaître comme incorporée au droit international cette interdiction, qui s'impose également à la conscience et à la pratique des nations . . . .*[224]

French version referred to "*l'emploi a la Guerra de gaz asphyxiants, toxiques ou similares*." *See* Geneva Protocol, *supra* note 23. For the interpretation that the protocol did not ban tear gas, the United States, which argued for the legality of use of "non-lethal gases" in war, relied on the word "*similares*" (similar) in the French version of the protocol, rather than "*autres*" which would have been a direct translation of the word "other," as in the English version. *See* VERWEY, *supra* note 170, at 226–27 (discussing implications arising from apparently conflicting texts in the French and English versions of the protocol). The United States took the position that while "other" gases might include tear gases, they were not "similar" to toxic or asphyxiating gases. *See id.* at 227; *cf. Limitations on Use of Chemical and Bacteriological Agents in Warfare: Hearing Before the Subcomm. on Disarmament of the Committee on Foreign Relations*, 90th Cong. 55 (1967) [hereinafter *1967 S. Hearings on Chemical Agents*] (testimony of Cyrus Vance, U.S. Deputy Sec'y of Def.); *1967 S. Hearings on Arms*, *supra* note 221, at 62 (statement of Cyrus Vance, U.S. Deputy Sec'y of Def.) (stating that the United States has "used riot-control agents in Vietnam—agents similar to those used by police forces throughout the world"); *see also* OFFICE OF PUB. AFFAIRS, U.S. ARMS CONTROL AND DISARMAMENT AGENCY, INTERNATIONAL NEGOTIATIONS ON THE BIOLOGICAL—WEAPONS AND TOXIN CONVENTION 40 (1975) ("[T]he ambiguity of the protocol on riot-control agents had been recognized for 40 years."). *See generally* R. R. Baxter & Thomas Buergenthal, *Legal Aspects of the Geneva Protocol of 1925*, 64 AM. J. INT'L L. 853 (1970) (discussing the validity of the U.S. argument); George Bunn, *Banning Poison Gas and Germ Warfare: Should the United States Agree?*, 1969 WIS. L. REV. 375 (1969) (same).

223. Geneva Protocol, *supra* note 23.

224. *Id.*

The historical and textual analysis above[225] is equally applicable here. There is simply no doubt that the authors had in mind, given their then current knowledge and environment, a concern that limiting the treaty to analogous liquids and materials might miss something that had already been used or which could be developed, and that the inclusion of "devices" was no accident. That conclusion is strongly supported by the French use of the word "*procédés*" in lieu of alternative phraseologies.[226] As will be seen below, the 1925 protocol has been incorporated into newer treaties, but it has never ceased to bind either its signatories or other states as an expression of customary law.[227] The protocol did not entirely eliminate use in war of toxic or asphyxiating chemical weapons, but, as the following discussion shows, their use was certainly curtailed after 1925.

iv. Practical Effect of the Protocol and Other Post-War Law After 1925

Although chemical stockpiles continued to grow long after the 1925 protocol entered into effect, their actual use in war was greatly curtailed.[228] While there was some documented use, both before the protocol, the United Kingdom in Siberia (1919, arsenicals)[229] and the Third Rif War (1924, mustard gas),[230] and

225. *See* discussion *supra* Part II.A.1.d.i.

226. *See* discussion *supra* Part II.A.1.d.i.

227. The United States, for example, even before ratification in 1975, repeatedly recognized the declaratory nature of the 1925 protocol. *See 1967 S. Hearings on Chemical Agents*, *supra* note 222, at 55 (testimony of Cyrus Vance, U.S. Deputy Sec't of Def.) ("We supported the Unites States affirmative vote in the United Nations General Assembly . . . on a resolution calling on all nations to observe the principles and objectives of the Geneva protocol of 1925. We have observed these principles consistently since 1925, although the United States . . . did not ratify the Geneva protocol.").

228. *See generally* Julian Perry Robinson, *The Negotiations on the Chemical Weapons Convention: A Historical Overview*, *in* THE NEW CHEMICAL WEAPONS CONVENTION: IMPLEMENTATION AND PROSPECTS 17 (M. Bothe et al. eds., 1998).

229. KETTLE, *supra* note 212, at 316.

230. During the Third Rif War in Spanish Morocco between 1921 and 1927, the Spanish Army of Africa dropped chemical warfare agents in an attempt to put down the Berber rebellion. RUDIBERT KUNZ & ROLF-DIETER MÜLLER, GIFTGAS GEGEN ABD EL KRIM: DEUTSCHLAND, SPANIEN UND DER GASKRIEG IN SPANISCH-MAROKKO, 1922–1927 (1990); *cf.* DAVID WOOLMAN, REBELS IN THE RIF: ABD EL KRIM AND THE RIF REBELLION (1968).

afterwards, Italy in Ethiopia (1936, mustard gas)[231] and Japan in China (1937–1945, certainly mustard and biological warfare, possibly other gases),[232] usage was generally limited to attacks by colonial powers on those with no means of reprisal who were viewed by the user as engaged in otherwise illegitimate warfare.[233] While there have been disputed allegations of various uses of chemical or toxic weapons as late as after World War II,[234]

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231. A.J. BARKER, THE RAPE OF ETHIOPIA 1936, 56–57 (1971) ("[W]hile Rome was rejecting the accusations, the Ethiopians were being systematically softened up with gas attacks . . . . [N]ot only was gas used throughout the war, but afterwards as well to break down the resistance of the Ethiopian freedom fighters."). Much later, the International Committee of the Red Cross ("ICRC") documented Italian use of mustard gas in a report filed by Doctor Marcel Junod of the ICRC delegation to Ethiopia:

> Junod also confronted the appalling reality of mustard gas and its effects: "That evening [18 March 1936] I had occasion to see with my own eyes an Italian aircraft spraying the ground with an oily liquid, dropping like fine rain and covering a huge area with thousands of droplets, each of which, when it touched the tissues, made a small burn, turning a few hours later into a blister. It was the blistering gas the British call mustard gas. Thousands of soldiers were affected by severe lesions due to this gas . . . ."

Bernard Bridel, *Les ambulances à croix rouge du CICR sous les gaz en Ethiopie* [*ICRC Red Cross Ambulances Gassed in Ethiopia*], LE TEMPS (Switz.), Aug. 13, 2003, *partially translated at* http://www.icrc.org/web/eng/siteeng0.nsf/html/5RUHGM.

232. According to historians Yoshiaki Yoshimi and Seiya Matsuno, chemical weapons were authorized by specific orders given by Emperor Shōwa himself, transmitted by the chief of staff of the army. For example, the emperor authorized the use of toxic gas on 375 separate occasions during the battle of Wuhan from August to October of 1938. They were also used during the invasion of Changde. Those orders were transmitted either by Prince Kotohito Kan'in or General Hajime Sugiyama. *See* HERBERT P. BIX, HIROHITO AND THE MAKING OF MODERN JAPAN 361 (2000) (citing Yoshiaki Yoshimi & Seiya Matsuno, *Dokugasusen Kankei Shiryō II,Kaisetsu* [*Materials on Poison Gas Warfare*], *in* KAISETSU, HŌKAN 2, JŪGONEN SENSÔ GOKUHI SHIRYŌSHŪ (Funi Shuppankan 1997) (Japan)). Japan deployed biological weapons against the Chinese a number of times through "Unit 731" of the Japanese Imperial Army. *See id.* at 364. *See generally* DANIEL BARENBLATT, A PLAGUE UPON HUMANITY: THE HIDDEN HISTORY OF JAPAN'S BIOLOGICAL WARFARE PROGRAM (2004). Unused Japanese mustard gas stocks in northeast China were inadvertently released as recently as August 2003, injuring a number of civilians. The Chinese government apparently claims an estimate of over 700,000 remaining Japanese chemical munitions. *See* Wu Gang & Li Jing, *Japanese Weapon Container Dug Up*, CHINA DAILY (English ed.), May 26, 2004, at 1.

233. *See, e.g.*, Javier Espinosa, *Gas Mostaza Sobre el Rif* [*Mustard Gas on the Rif*], EL MUNDO (Madrid), Apr. 18, 2001, http://www.elmundo.es/2001/04/18/sociedad/983737.html (referencing a telegram sent by the then-High Commissioner of Spanish Morocco Damaso Berenguer to the Spanish minister of War in the Third Rif War on August 12, 1921, stating: "I have been obstinately resistant to the use of suffocating gases against these indigenous peoples but after what they have done, and of their treasonous and deceptive conduct, I have to use them with true joy" (author's translation)).

234. There was speculation that Russians used chemical poisons in aerial offensives in East Asia. *See, e.g.*, *Yellow Rain*, TIME, Sept. 14, 1981, at 22 (alleging Soviet use of "the

documented use by states seems to be limited to the Iran-Iraq War and to internal Iraqi conflicts. During this period, the Iraqi government attacked its own rebellious citizens and Iran.[235]

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chemical agent trichothecene toxin, known as T2."). *See generally* STERLING SEAGRAVE, YELLOW RAIN: A JOURNEY THROUGH THE TERROR OF CHEMICAL WARFARE (1982) (documenting the alleged uses of T2 by the Russian military). Egyptian bombers allegedly used mustard and other nerve agents in Yemen against royalist rebels during the early- and mid-1960s. *See* TUCKER, *supra*, note 42, at 190–96 (discussing Egypt's alleged use of chemical agents).

235. This is documented by the respected international security analysis group GlobalSecurity:

> In 1982, early in the Iran-Iraq War, the Iraqis used riot control agents to repel Iranian attacks. They progressed to the use of CW agents in mid-1983 with mustard, and in March 1984 with tabun (the first use ever of a nerve agent in war). The Iraqis continued to use chemical weapons until the end of hostilities in August 1988; in addition they introduced the nerve agents sarin and GF late in the war.
>
> In March 1986, UN Secretary General Javier Perez de Cuellar formally accused Iraq of using chemical weapons against Iran. Citing the report of four chemical warfare experts whom the UN had sent to Iran in February and March 1986, the secretary general called on Baghdad to end its violation of the 1925 Geneva Protocol on the use of chemical weapons. The UN report concluded that "Iraqi forces have used chemical warfare against Iranian forces"; the weapons used included both mustard gas and nerve gas. The report further stated that "the use of chemical weapons appear[ed] to be more extensive [in 1981] than in 1984." Iraq attempted to deny using chemicals, but the evidence, in the form of many badly burned casualties flown to European hospitals for treatment, was overwhelming. By July 1986 it was estimated that Iraqi chemical warfare was responsible for about 10,000 casualties.
>
> Although the Iraqis initially used chemical weapons to prevent defeat and to reduce battlefield losses, they later integrated CW attacks into combined-armed operations designed to regain lost territory and to gain the offensive. Iraq's use of CW in the war with Iran can be divided into three distinct phases:
>
> 1. 1983 to 1986–used in a defensive role; typically to deflect Iranian human-wave assaults. In 1984 Iraq became the first nation to use a nerve agent on the battlefield when it deployed Tabun-filled aerial bombs during the Iran-Iraq war. Some 5,500 Iranians were killed by the nerve agent between March 1984 and March 1985. Tabun kills within minutes. Some 16,000 Iranians were reported killed by the toxic blister agent mustard gas between August 1983 and February 1986.
> 2. 1986 to early 1988–iraq adapts use against Iran to disrupt Iranian offensive preparations.
> 3. early 1988 to conclusion of the war– Iraq integrated large nerve agent strikes into its overall offensive during the spring and summer of 1988 leading to the ceasefire.
>
> Iran used chemical weapons late in the war, but never as extensively or successfully as Iraq. The success of Iraqi offensive operations in the southern sector in mid-1988 ultimately caused the Iranians to cease hostilities. The use of chemical weapons contributed to the success of these operations.

These attacks are the only general use of mustard gas in continuous and open conflict since 1918, and the first fully documented use of nerve gases in war. It is worth noting that in the case of both Japan and Iraq, the League of Nations and the United Nations ("U.N."), respectively, took the position that those states were engaged in violations of the 1925 protocol.[236]

The Iran-Iraq War started in 1982, and by early 1984 the press was reporting Iranian allegations regarding Iraqi use of toxic chemical weapons.[237] By mid-1984, a U.N. investigating mission found evidence of Iraqi use of nerve agents.[238] In early 1986, in light of Iranian allegations of renewed Iraqi use of chemical weapons, and threats to retaliate in kind, the Security Council passed Resolution 582 noting that:

> [B]oth the Islamic Republic of Iran and Iraq are parties to the 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 17 June 1925 . . . [The Secretary-General] *[a]lso deplores* . . . in particular, *the use of chemical weapons contrary to obligations under the 1925 Geneva Protocol* . . . .[239]

Immediately following the adoption of that resolution, Secretary-General Perez de Cuellar instructed an investigating mission to

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Chemical Weapons Programs – Iraq Special Weapons Facilities, http://www.globalsecurity.org/wmd/world/iraq/cw-program.htm (last visited Apr. 3, 2010).

236. *See, e.g.*, Pres. of the Sec. Council, *Note by the President of the Security Council*, U.N. Doc. S/17932 (Mar. 21, 1986) ("The Council strongly condemn this continued use of chemical weapons in clear violation of the Geneva Protocol of 1925 which prohibits the use in war of chemical weapons."); *Appeal by the Chinese Government*, 19 L.N.O.J. 878 (reminding Japan that "the use of toxic gases is a method of war condemned by international law, which cannot fail, should resort be had to it, to meet with the reprobation of the civilized world"). Japan, of course, had at that time withdrawn from the League, and simply ignored its call for negotiations. U.S. Department of State, Background Note: Japan, Sept. 2009, http://www.state.gov/r/pa/ei/bgn/4142.htm (documenting Japan's withdrawal from the League of Nations in 1933).

237. *See* Bernard Gwertzman, *U.S. Says Iraqis Used Poison Gas Against Iranians in Latest Battles*, N.Y. TIMES, at A1; *see also* Julian Robinson & Jozef Goldblat, *Chemical Warelfare in the Iraq-Iran War 1980-1988*, SIPRI FACT SHEET, 1984, *available at* http://www.iranchamber.com/history/articles/chemical_warfare_iran_iraq_war.php.

238. *See Report of the Specialists Appointed by the Secretary-General to Investigate Allegations by the Islamic Republic of Iran Concerning the Use of Chemical Weapons*, U.N. Doc. S/16433 (Mar. 26, 1984).

239. S.C. Res. 582, ¶ 2, U.N. Doc. S/RES/582 (Feb. 24, 1986). (second emphasis added).

proceed to Iran.[240] The mission submitted a report to the Secretary-General on March 7, 1986.[241] Medical observations, chemical analysis, and examination of unexploded munitions demonstrated unquestionable and extensive Iraqi use of mustard gas.[242] The Iraqi use of chemical warfare against Iran was the only extensive use of such weapons in a major war since World War I. However, it was not the only time that use of such weapons was considered.

As has been discussed above, following World War I there was a considerable lobby in various militaries for the development of, possession of, and preparation to use chemical weapons.[243] In addition to German weapon developments, the World War II Allies possessed and deployed extensive stocks of chemical weapons,[244] and were prepared to use them if necessary (although the definition of "necessity" varied).[245]

Following the end of World War II, the principal developers and stock-pilers of chemical weapons were the United States and the Union of Soviet Socialist Republics ("U.S.S.R.").[246] Both sides used prior German research and their own development work to test and deploy both the G-series of nerve gases, and the V-series of increasingly deadlier materials, both chemical and

240. *See* The Secretary-General, *Report of the Mission Dispatched by the Secretary-General to Investigate Allegations of the Use of Chemical Weapons in the Conflict Between the Islamic Republic of Iran and Iraq*, ¶9, U.N. Doc. S/17911 (Mar. 12, 1986).

241. *See id.* at ¶11.

242. *See id.* at ¶ 20.

243. *See supra* note 221 and accompanying text.

244. For example, a U.S. Liberty ship, *S.S. John Harvey*, was sunk in the port of Bari, Italy, on December 2, 1943, with a cargo of 1350 tons of mustard gas on its way to Army forward storage depots. *See* RICK ATKINSON, THE DAY OF BATTLE: THE WAR IN SICILY AND ITALY 1943–1944, at 271–77 (2007).

245. U.S. President Franklin Roosevelt was only prepared to use chemical weapons in reprisal for chemical attack. In fact, he overruled a plan to use mustard against the Japanese on Iwo Jima. *See* COLONEL JOSEPH H. ALEXANDER, CLOSING IN: MARINES IN THE SEIZURE OF IWO JIMA 48 (1994). In contrast, U.K. Prime Minister Winston Churchill several times urged the use of mustard gas, stating, "I want a cold-blooded calculation made as to how it would pay us to use poison gas, by which I mean principally mustard . . . . I want the matter studied in cold blood by sensible people and not by that particular set of psalm-singing uniformed defeatists which one runs across now here now there." *See* Bernstein, *supra* note 110. The British were fully prepared to do so to repel a German invasion on the beaches. *See* Christopher Bellamy, *Sixty Secret Mustard Gas Sites Uncovered*, INDEP. (London), Jun. 4, 1996, at 2.

246. *See* TUCKER, *supra* note 42, at 154. There was other participants in the race, including France, the People's Republic of China, and the United Kingdom. *See id.* at 153.

biological.[247] Eventually, the following factors pushed the main actors towards signing and ratifying two new conventions: (1) the increasing and real possibility of actual use in warfare; (2) accidental releases;[248] (3) criminal or inadvertent transfers of chemical or biological weapons to other countries or non-state actors;[249] and (4) and the possibility of independent development and deployment by terrorists.[250]

2. 1972 Bacteriological and Toxin Weapons Convention

On April 10, 1972, the BWC opened for signature. After twenty-two governments deposited their instruments of ratification the treaty entered into force on March 26, 1975.[251] It was the first multilateral disarmament treaty banning an entire class of weapons.[252] As of February 2010, the BWC had 163 states parties and thirteen signatories.[253] There are still as of yet nineteen states that have neither signed nor ratified the BWC.[254]

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247. *See id.* at 154.

248. *See* KEN ALIBEK & STEPHEN HANDELMAN, BIOHAZARD: THE CHILLING TRUE STORY OF THE LARGEST COVERT BIOLOGICAL WEAPONS PROGRAM IN THE WORLD—TOLD FROM INSIDE BY THE MAN WHO RAN IT 71–76 (1999) (explaining the accidental release by the U.S.S.R. of weaponized anthrax at Sverdlovsk—now Yekaterinburg—on April 2, 1979). This release occurred after the U.S.S.R had already ratified the BWC. *See infra* note 252. This situation represents one aspect of the verification and enforcement problems implicit in any arms control treaty of this nature.

249. *See* MICHAEL JOHN GARCIA, CONGRESSIONAL RESEARCH SERV., BIOLOGICAL AND CHEMICAL WEAPONS: CRIMINAL SANCTIONS AND FEDERAL REGULATIONS 4–8 (2004); *see also* Treasa Dunworth et al., *National Implementation of the Biological Weapons Convention*, 11 J. CONFLICT & SECURITY L. 93 (2006); Int'l Crisis Group, *North Korea's Chemical and Biological Weapons Programs*, ICG Asia Report No. 167 (2009).

250. *See* TUCKER, *supra*, note 42 at 333; *see also* Kyle B. Olson, *Aum Shinrikyo: Once and Future Threat?*, 5 EMERGING INFECTIOUS DISEASES 513 (1999).

251. *See* Biological Weapons Convention, *supra* note 13, art. XIV(3); *see also* BWC Implementation Support Unit, Office for Disarmament Affairs, *Biological Weapons Convention: Background Information* (n.d.), *available at* http://www.unog.ch/80256edd006b8954/(httpassets)/699b3ca8c061d490c1257188003b9fee/$file/bwc-background_inf.pdf.

252. Banning an entire class of weapons stands in contrast to banning types of weapons, such as the ban against exploding bullets as required under the St. Petersburg Convention of 1868. Declaration Renouncing the Use, in Time of War, of Explosive Projectiles Under 400 Grammes Weight, Nov. 29–Dec. 11, 1868, 18 Martens Nouveau Recueil (ser. 1) 474 [hereinafter St. Petersburg Declaration].

253. *See* Membership of the Biological Weapons Convention, http://www.unog.ch/80256ee600585943/(httppages)/7be6cbbea0477b52c12571860035fd5c (last visited Apr. 3, 2010).

254. *See id.*

The United Kingdom, United States, and Russian Federation are the BWC's depositaries.[255]

States parties to the BWC undertake "never in any circumstances to develop, produce, stockpile, or otherwise acquire or retain" the following class of substances:

> microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes; [or] weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.[256]

As noted above, both the BWC and the CWC incorporate the text of the Geneva Protocol.[257] That incorporation is important for several reasons discussed above,[258] but it also operates as a gap-filler in any potential areas of doubt where an argument might be made that an engineered virus was not the equivalent of nanomachines,[259] and not yet a living thing intended to fall within the BWC.[260] In fact, the BWC and CWC overlap because they both incorporate the Geneva Protocol and because they both cover toxins.[261] This overlap and incorporation must inform

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255. *See* Biological Weapons Convention, *supra* note 13, art. XIV(2).

256. *See id.*

257. *See supra* note 22 and accompanying text.

258. *See supra* notes 24–27 and accompanying text.

259. At least some experts have informed the Author that engineered viruses are, for all intents and purposes, nanomachines. This information was obtained at a conference with the Author on July 8, 2009, in Washington D.C., in which he agreed to keep confidential the names of participants and specific quotations.

260. For two reasons, there is no doubt the BWC could be fairly interpreted to include even engineered viruses: 1) the inclusion of smallpox within the BWC even though a virus is not *per se* a living thing; 2) the generally accepted scientific conclusion that a virus is in fact a biological entity. *See* Robert Edwards & Forest Rohwe, *Viral Metagenomics*, 3 NATURE REVIEWS MICROBIOLOGY 504 (2005). Given the potentially grave consequences of the use of engineered viruses as weapons, it is important that we interpret the BWC as covering their usage for banned purposes.

261. There is overlap between biological warfare and chemical warfare as the use in war of toxins, whether produced by living organisms, or otherwise, is banned under the provisions of both the BWC and the CWC. Considerable interpretative value may be found in definitional section of the relevant U.S. statute. 18 U.S.C. § 178 2–4 (2006) defines criminally banned biological weapons:

> (2) the term "toxin" means the toxic material or product of plants, animals, microorganisms (including, but not limited to, bacteria, viruses, fungi, rickettsiae or protozoa), or infectious substances, or a recombinant or synthesized molecule, whatever their origin and method of production, and includes—

the upcoming analysis on application to new and developing nanomaterials.

3. 1993 Chemical Warfare Convention

The CWC was the culmination of a long period of international negotiation.[262] It was opened for signature on January 13, 1993,[263] and entred into force on April 29, 1997, after the sixty-fifth state party deposited its ratification instrument six months earlier.[264] As of February 2010, the treaty has 188 states parties and two signatories.[265]

The CWC is designed to eliminate an entire category of weapons of mass destruction by prohibiting the development, production, acquisition, stockpiling, retention, transfer, and use of chemical weapons.[266] Excepted from this general prohibition

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(A) any poisonous substance or biological product that may be engineered as a result of biotechnology produced by a living organism; or
(B) any poisonous isomer or biological product, homolog, or derivative of such a substance;

(3) the term "delivery system" means—
(A) any apparatus, equipment, device, or means of delivery specifically designed to deliver or disseminate a biological agent, toxin, or vector; or
(B) any vector;

(4) the term "vector" means a living organism, or molecule, including a recombinant or synthesized molecule, capable of carrying a biological agent or toxin to a host

Id.

262. *See* United Nations Department for Disarmament Affairs, http://www.un.org/Depts/dda/WMD/cwc/ (last visited Apr. 3, 2010) (specifically, "a decade of long and painstaking negotiations").

263. *See* Status of the CWC, http://treaties.un.org/pages/viewdetails.aspx?mtdsg_no=XXVI-3&chapter=26&lang=en (last visited Apr. 3, 2010). Even before the CWC was opened for signature, the U.N. General Assembly passed a resolution on November 30, 1992 that read, "Bearing in mind the Final Declaration of the *Conference of States Parties to the 1925 Geneva Protocol* and Other Interested States, held in Paris from 7 to 11 January 1989, in which participating States stressed their determination to prevent any recourse to chemical weapons by completely eliminating them." G.A. Res. 47/39, pmbl., U.N. Doc. A/RES/47/39 (Nov. 30, 1992) (emphasis added).

264. *See* Chemical Weapons Convention, *supra* note 10, art. XXI(1); *see also* Status of the CWC, *supra* note 263.

265. *See* Status of the CWC, *supra* note 263.

266. Chemical Weapons Convention, *supra* note 10, art. I(1) State parties are also obligated under Article 1 to destroy all existing stockpiles of chemical weapons, chemical weapons abandoned in the territory of another state party, and chemical weapon production facilities. *See id.* art. I(2)–(4). Article 2 of the CWC includes key definitions for the terms "chemical weapons" and "toxic chemicals." *See supra* note 33.

are legal uses intended for peaceful purposes.[267] The treaty's categorical prohibition of chemical weapons is administered by the Organisation for the Prohibition of Chemical Weapons ("OPCW"),[268] which conducts inspection of military and industrial plants in all of the member nations, and works with stockpile countries. All parties are also required to submit a declaration concerning their possession of current chemical weapons, old chemical weapons, and production facilities upon sighning the treaty.[269]

The CWC identifies three classes of controlled chemicals which can either be used as weapons or in the manufacture of weapons.[270] Classification is based on the quantities of the substance produced commercially for legitimate purposes.[271] Each class is split into two parts: part A covers chemicals that can be used directly as weapons and part B extends coverage to chemicals useful in the manufacture of chemical weapons.[272] The annexes and schedules incorporated within the CWC provide the criteria for defining these groups of chemicals.[273] Chemicals listed in schedule 1 have few or no uses outside of chemical weapons;[274] while production or use of these chemicals may be permissible for research, medical, pharmaceutical, or chemical

267. Chemical Weapons Convention, *supra* note 10, art. VI ("Each State Party has the right, subject to the provisions of this Convention, to develop, produce, otherwise acquire, retain, transfer and use toxic chemicals and their precursors for purposes not prohibited under this Convention."). The convention goes on to define "purposes not prohibited under this convention" as "(a) Industrial, agricultural, research, medical, pharmaceutical or other peaceful purposes; (b) Protective purposes, namely those purposes directly related to protection against toxic chemicals and to protection against chemical weapons; (c) Military purposes not connected with the use of chemical weapons and not dependent on the use of the toxic properties of chemicals as a method of warfare; (d) Law enforcement including domestic riot control purposes." *See id.* art. II(9); *see also* S. Exec. Res. 75, 105th Cong. (1997) ("[R]equiring the President to certify to Congress on an annual basis that "the legitimate commercial activities and interests of chemical, biotechnology, and pharmaceutical firms in the United States are not being significantly harmed by the limitations of the Convention on access to, and production of, those chemicals and toxins listed in Schedule 1.").

268. Chemical Weapons Convention, *supra* note 10, art. VIII(A).

269. *See id.*, art. III(1).

270. *See id.*, Annex on Chemicals.

271. *See id.*, sec. A.

272. *See id.*, sec. B.

273. *See id.*

274. *See id.*, sec. A(1). Examples of schedule 1 chemicals are mustard gas, nerve agents, and substances solely used as precursor chemicals in their manufacture. *See id.*, sec. B, sched. 1.

weapon defense testing purposes, production above one hundred grams per year must be declared to the OPCW.[275] Each country is limited to possessing a maximum of one ton of these materials.[276] Chemicals listed in schedule 2 have legitimate small-scale applications;[277] manufacture of these chemicals must be declared, and export of these chemicals to non-CWC countries is limited.[278] Chemicals listed in schedule 3 have large-scale industrial uses apart from chemical weapons.[279] Plants that manufacture more than thirty tons of schedule 3 chemicals per year must declare the produced quantity and subject themselves to inspection; additionally, there are restrictions on export of schedule 3 chemicals to non-CWC countries.[280]

The treaty also deals with "discrete organic compounds."[281] Unless a plant solely produces explosives or hydrocarbons, the OPCW must be informed of and may inspect any plant producing or expecting to produce more than two hundred tons of discrete organic compounds per year, or thirty tons if the chemical contains phosphorus, sulfur, or fluorine.

A U.N. publication on disarmament negotiations accurately reports that:

> [T]he Geneva Protocol of 1925 and the Biological Warfare Convention of 1972 are relatively simple as far as their content and mechanisms of implementation are concerned. It became increasingly clear at the beginning of the 1970s that such a simple approach to a comprehensive ban on chemical weapons was not acceptable to some countries, particularly the United States and the United Kingdom. One of the reasons given was that chemical weapons had a higher military value than biological . . . . Therefore, especially Western countries believed that international verification of compliance with a total prohibition of chemical weapons

275. *See id.*, Annex on Implimentation and Verification, pt. VI.

276. *See id.*

277. *See id.*, Annex on Chemicals, sec. A(2).

278. *See id.*, Annex on Implementation and Verification, pt. VII.

279. *See id.*, Annex on Chemicals, sec. A(3). For example, phosgene is a precursor in the manufacture of many legitimate organic materials. *See id.*, Annex on Implementation and Verification, pt. VII.

280. *See id.*

281. *Id.*, pt. IX(A). The United States defines discrete organic chemicals as any carbon compounds apart from long chain polymers, oxides, sulfides and metal carbonates. *See* U.S. Dep't of Commerce, Unscheduled Discrete Organic Chemicals, http://www.cwc.gov/index_chemicals_udoc.html (last visited Apr. 3, 2010).

> should be more intrusive in order to ensure the security of all parties to the agreement.[282]

All parties to the CWC agree never to develop, produce, acquire, possess, transfer, prepare to use, or use chemical weapons.[283] Through its detailed definitions, its declaration requirement,[284] and the OPCW, the CWC creates a regime with very broad reach; the incorporation of the Geneva Protocol and the BWC's parallel obligations greatly amplify the probability that most nanotechnology products with toxic or poisonous application in war will fall within the CWC's regime. A number of other potentially applicable treaties and international law doctrines are worth at least a brief mention here as well.

B. *Other Potentially Applicable Treaties and Doctrines*

In addition to the treaties discussed above, a number of other treaties and binding principles of international law may impact nanoparticles and nanomimics and their use as weapons of war.[285] There are several treaties that, although not facially applicable to nanobots, may nevertheless impact their use in warfare. Similarly, there are also several general doctrines which may bear on the use of nanobots that are worth mentioning.

1. Geneva Conventions III and IV, and Additional Protocol I of 1977

The Geneva Convention Relative to the Treatment of Prisoners of War ("Geneva Convention III")[286] and the Geneva Convention Relative to the Protection of Civilians ("Geneva Convention IV")[287] include several articles that generally impact gas warfare in the context of prisoners of war ("POWs"). In particular, Geneva Convention III requires continued gas

282. BERNAUER, *supra* note 147, at 1.

283. *See, e.g.*, Chemical Weapons Convention, *supra* note 10, art I.

284. *See id.*, art. III.

285. *See generally* Kelly, *supra* note 139.

286. Geneva Convention Relative to the Treatment of Prisoners of War; Aug. 12, 1949, 6 U.S.T. 3316, 75 U.N.T.S. 135 [hereinafter Geneva Convention III].

287. Geneva Convention Relative to the Protection of Civilian Persons in Time of War, Aug. 12, 1949, 6 U.S.T. 3516, 75 U.N.T.S. 287 [hereinafter Geneva Convention IV].

protection for POWs,[288] and Geneva Convention IV requires gas protection for internees.[289]

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288. Article 18 of the Geneva Convention Relative to the Treatment of Prisoners of War ("Geneva Convention III") states the following:

> [A]ll effects and articles of personal use, except arms, horses, military equipment and military documents, shall remain in the possession of prisoners of war, likewise their metal helmets and gas masks and like articles issued for personal protection. Effects and articles used for their clothing or feeding shall likewise remain in their possession, even if such effects and articles belong to their regulation military equipment.

Geneva Convention III, *supra* note 286, art. 18. Note that the ICRC interprets Geneva Convention III as specifically requiring gas protection for prisoners of war:

> [T]he requirement that prisoners of war must have shelters against air bombardment "to the same extent as the local civilian population" implies that . . . shelters must be supplied for prisoners of war in the same conditions as for the civilian population . . . . *If civilian workers employed in a particular industry are issued with special equipment for use during air-raids (gas masks, protective clothing, etc.), such equipment must also be made available to prisoners of war.*

INT'L COMM. OF THE RED CROSS, COMMENTARY ON THE THIRD GENEVA CONVENTION RELATIVE TO THE TREATMENT OF PRISONERS OF WAR 188(Jean S. Pictet ed., 1960) (emphasis added) (quoting Geneva Convention III, *supra* note 286, art. 23).

289. Article 85 of the Geneva Convention Relative to the Treatment of Civilians states the following:

> [T]he Detaining Power is bound to take all necessary and possible measures to ensure that protected persons shall, from the outset of their internment, be accommodated in buildings or quarters which afford every possible safeguard as regards hygiene and health, and provide efficient protection against the rigors of the climate and the effects of the war.

Geneva Convention IV, *supra* note 287, art. 85. Additionally, article 88 states:

> [I]n all places of internment exposed to air raids and other hazards of war, shelters adequate in number and structure to ensure the necessary protection shall be installed. In case of alarms, the measures internees shall be free to enter such shelters as quickly as possible, excepting those who remain for the protection of their quarters against the aforesaid hazards. Any protective measures taken in favor of the population shall also apply to them.

Id. art. 88. Furthermore, a 1991 U.N. report concerning Israel's Geneva Convention IV obligations to Palestinians in the occupied territories with respect to gas protection informs this point of inquiry:

> Since the inception of the crisis, Iraq had repeatedly threatened to attack Israel with conventional and non-conventional weapons in the event of hostilities. As part of its civil defense procedures, Israel provided to its citizens gas masks and related equipment for protection against a chemical attack. The Israeli authorities also issued gas masks to the Palestinian residents of Jerusalem. United Nations officials in the area repeatedly expressed concern about the need of the Palestinian population as a whole to be given such equipment. On 14 January 1991, the Israeli High Court of Justice ruled as follows: "The Military Commander must indeed exercise equality in the area. He may not discriminate between residents. *When the Military Commander has reached the conclusion that protective kits must be distributed to Jewish residents in the*

Other relevant provisions are found in the 1977 Protocol Additional to the Geneva Conventions of 12 August 1949 ("Protocol I").[290] Although a large part of Protocol I is at least in some way related to protecting against the utilization of any weapon,[291] certain portions have particular application to the nanoweapons discussed here. This is particularly true of article 36:

> [I]n the study, development, acquisition or adoption of a new weapon, means or method of warfare, a High

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area, protective kits must also be distributed to the area's Arab residents." The High Court ordered that

> "[F]irst, the 173,000 gas masks presently in stock in emergency warehouses must be immediately distributed to adults living in the areas surrounding Jerusalem, as well as in those areas near the Green Line. Second, all efforts possible should be made to secure masks for the children of these adults, and these masks must be distributed immediately upon their being obtained. Third, all residents of the area should receive masks immediately upon their being purchased by the Military Commander. The Military Commander must make every possible effort to secure these masks as soon as possible."

Despite the urgency expressed in the decision of the High Court, the distribution of gas masks from Israel's existing stock proceeded slowly. The IDF spokesman's office told B'Tselem, an Israeli human rights organization, that, as of 2 February 1991, 50,000 masks had been given out. Those that were distribution lacked the atropine and decontamination powder contained in the kits provided to Israeli citizens. Few, if any, masks were made available to Palestinian children. Furthermore, the vast majority of Palestinian detainees - many of whom are housed in tents and therefore more vulnerable in the event of an attack—were not given gas masks. For its part, UNRWA launched an appeal and received, from international donors, 62,000 masks for adults. Its distribution of the masks was slowed by the fact that the Israeli authorities requested that they be delivered on a house-to-house basis during the curfews.

The Secretary-General, *Report Submitted to the Security Council by the Secretary-General in Accordance with Resolution 681*, ¶11, *delivered to the Security Council*, U.N. Doc. S/22472 (Apr. 9, 1991) (emphasis added).

290. Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts, June 8, 1977, 1125 U.N.T.S. 3 [hereinafter Protocol I]. While this Article largely deals with international armed conflicts and discusses only Protocol I, the principles articulated would be precisely the same in a non-international conflict—excluding police use of lacrimators—as in Iraqi use against its citizens. Thus, Protocol II's strictures are at least worth noting as relevant. *See* Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of Non-International Armed Conflicts, June 8, 1977, 1125 U.N.T.S. 609. Notably, the United States is not party to Additional Protocol II of 1977. *See* States Parties / Signatories to Additional Protocol II of the Geneva Convention, http://www.icrc.org/ihl.nsf/websign?readform&id=475 (last visited Apr. 3, 2010).

291. *See, e.g.*, *id.* arts. 35, 51, 57.

> Contracting Party is under an obligation to determine whether its employment would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the High Contracting Party.[292]

While much of the discussion of nanoweapons presented here argues that they are simply old swine in new battles, to the extent that nanomimics do indeed represent anything that existing conventions do not cover, article 36 of Protocol 1 would clearly require advance determination of their legality. Other relevant provisions of Protocol I are are those relating to protection of the civilian populace,[293] and precautions required in attacks.[294]

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292. *See id.* art. 36.

293. Article 51 of Protocol I addresses protection of the civilian population:

1. The civilian population and individual civilians shall enjoy general protection against dangers arising from military operations. To give effect to this protection, the following rules, which are additional to other applicable rules of international law, shall be observed in all circumstances.

. . .

4. Indiscriminate attacks are prohibited. Indiscriminate attacks are:

(a) those which are not directed at a specific military objective;

(b) those which employ a method or means of combat which cannot be directed at a specific military objective; or

(c) those which employ a method or means of combat the effects of which cannot be limited as required by this Protocol; and consequently, in each such case, are of a nature to strike military objectives and civilians or civilian objects without distinction.

5. Among others, the following types of attacks are to be considered as indiscriminate:

(a) an attack by bombardment by any methods or means which treats as a single military objective a number of clearly separated and distinct military objectives located in a city, town, village or other area containing a similar concentration of civilians or civilian objects; and

(b) an attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated.

Id. art. 51.

294. Article 57 of Protocol I addresses precautions in attack:

1. In the conduct of military operations, constant care shall be taken to spare the civilian population, civilians and civilian objects.

2. With respect to attacks, the following precautions shall be taken:

(a) those who plan or decide upon an attack shall:

(i) do everything feasible to verify that the objectives to be attacked are neither civilians nor civilian objects and are not subject to special protection but are military objectives within the meaning of paragraph 2 of Article 52 and that it is not prohibited by the provisions of this Protocol to attack them;

2. The Early Poison Conventions

The ban on poisonous weapons is an ancient one.[295] Instructions for the Government of Armies of the United States in the Field ("General Order 100") is the first comprehensive modern articulation regulating armed conflict.[296] it provides, inter alia, that "the use of poison in any manner, be it to poison wells, or food, or arms, is wholly excluded from modern warfare. He that uses it puts him self [sic] out of the pale of the law and usages of war."[297] However, the stricture dates from well before the nineteenth century:

> [P]roscription of toxic weapons seems almost as ancient as the weapons themselves. The earliest surviving references to toxic warfare are probably those in the Indian epics . . . and it is to the Manu laws of India, which forbade the use of poison weapons, that a line of ancestry can be drawn . . . . It is a culturally diverse ancestry, reaching back not only through Hague and Roman law via Grotius, but also through the warfare regulations which the Saracens derived from the Koran.[298]

(ii) *take all feasible precautions in the choice of means and methods of attack with a view to avoiding, and in any event to minimizing, incidental loss or civilian life, injury to civilians* and damage to civilian objects;

(iii) refrain from deciding to launch any attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated;

(b) an attack shall be cancelled or suspended if it becomes apparent that the objective is not a military one or is subject to special protection or that the attack may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated;

(c) effective advance warning shall be given of attacks which may affect the civilian population, unless circumstances do not permit. 3. When a choice is possible between several military objectives for obtaining a similar military advantage, the objective to be selected shall be that the attack on which may be expected to cause the least danger to civilian lives and to civilian objects.

Id. art. 57 (emphasis added).

295. *See, e.g.*, *supra* note 1.

296. *See* LIEBER, *supra* note 125.

297. *Id.* art. 70.

298. Robinson, *supra* note 228, at 17.

Thus, article 23(a) of the annex to the Hague Convention of 1907 Respecting the Laws and Customs of War ("Hargue Convention IV") provides that "[i]t is especially forbidden to employ poison or poisoned weapons."[299] This language, however, must be balanced against its past interpretations, and states rejecting any applicability to poisonous or asphyxiating gases.[300] According to the International Court of Justice in the *Nuclear Weapons Advisory Opinion*, the "prime or even exclusive effect" of a weapon must be to poison in order to qualify as poisonous within the meaning of the annex to Hague Convention IV.[301]

Because these agreements concerned toxic and asphyxiating gases and smokes, the early bans against poisons were ignored or distinguished by state usage,[302] and in any case have been superseded by the Geneva Protocol, BWC, and CWC, which are now the recognized source of international law due to their specificity and effectiveness.[303]

3. Conventional Weapons Convention

The Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects ("Conventional Weapons Convention")[304] entered into force on December 2, 1983.[305] The only potentially applicable portion of the Conventional Weapons Convention appears to be Amended Protocol II, which entered into force in 1998 ("Amended Protocol II")[306] and covers landmines, booby-traps, and "other

299. Convention Respecting the Laws and Customs of War on Land, Annex art. 23(a), Oct. 18, 1907, 36 Stat. 2277, 205 Consul. T.S. 277 [hereinafter Hague Convention IV].

300. *See* Kelly, *supra* note 285, at 44.

301. Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, 248 (July 8).

302. *Cf. supra* notes 132–44, 222 (discussing Germany's attempts to legitimize its use of chemical weapons under previous treaties and U.S. use of tear gas under the 1925 Geneva Protocol).

303. *See* CLIVE PARRY, THE SOURCES AND EVIDENCES OF INTERNATIONAL LAW 51–52 (1965).

304. *See* Conventional Weapons Convention, *supra* note 164.

305. *See id.* art. 5(1), (3); Status of the Conventional Weapons Convention, http://treaties.un.org/pages/viewdetails.aspx?src=treaty&mtdsg_no=xxvi-2&chapter=26&lang=en (last visited Apr. 3, 2010).

306. *See* Status of Amended Protocol II to the Conventional Weapons Convention, http://treaties.un.org/pages/viewdetails.aspx?src=treaty&mtdsg_no=xxvi-2-b&chapter=

devices."[307] These are the most important elements of Amended Protocol II of the Conventional Weapons Convention: (1) use of landmines and booby-traps is highly regulated but not banned;[308] (2) anti-personnel landmines must be kept in clearly marked and protected minefields or be equipped with self-destruction and self-deactivation mechanisms that disarm and render the mines unusable after a relatively short period of time;[309] (3) mines scattered by aircrafts, artillery, or missiles require self-destruction and deactivation mechanisms;[310] (4) anti-personnel mines must be detectable by common mine detection equipment to enable their location and safe removal after a conflict;[311] (5) mine clearing responsibility rests with the government controlling the territory where mines are located.[312]

In the past, interest in mines from a chemical weapons perspective focused exclusively on their use as deployment devices; however, it is also interesting to look at some of the definitions in Amended Protocol II of the Conventional Weapons Convention. Most notably, "booby-trap" is defined more broadly than "mine." The definition of mine is "a munition . . . designed to be exploded," while the definition of booby-trap is "*any device* or material *which is designed*, constructed or adapted *to kill* or injure, and *which functions unexpectedly when a person* disturbs or approaches an apparently harmless object or *performs an apparently safe act.*"[313]

The facial argument for coverage of nanomimic devices as booby-traps—at least in circumstances where they affect a person performing an apparently safe act, such as breathing—is actually

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26&lang=en. The seventy-six countries bound by the protocol include most, but not all, of the world's major current or past landmine producers—China, India, Israel, Pakistan, Russia, and the United States—which have refused to join the Ottawa Convention banning anti-personnel landmines. *See id.*; *see also* Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction, Sept. 18, 1997, 2056 U.N.T.S. 211.

307. *See* Conventional Weapons Convention, *supra* note 164, Protocol II art. 1, *as amended*, May 3, 1996, S. TREATY DOC. NO. 105-1 (1997), 35 I.L.M. 1206 [hereinafter Amended Protocol II to the Conventional Weapons Convention].

308. *See* Amended Protocol II to the Conventional Weapons Convention, *supra* note 164, art. 3.

309. *See id.* art. 3, Technical Annex ¶ 2.

310. *See id.* art. 5, Technical Annex ¶ 1.

311. *See id.*

312. *See id.* art. 5(2).

313. *Id.* art. 2(1), (4) (emphasis added).

rather compelling. Article 3 of Amended Protocol II, which prohibits deployment against civilians or in an indiscriminate fashion, bolsters this argument.[314]

It would be ironic if a nanomachine were specifically designed to avoid coverage as a chemical weapon and incidentally fell within the coverage of another international ban. It is, however, a good point to keep in mind, for upon such ironies may the law be built.

4. Doctrinal Violations

Interestingly, the preamble of the 1925 Geneva Protocol states that "the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids materials or devices, has been

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314. Article 3 of Amended Protocol II articulates general restrictions on the use of mines, booby-traps, and other devices:

> 1. This Article applies to:
> . . .
> (b) booby-traps; and
> (c) other devices.
> . . .
> 3. It is prohibited in all circumstances to use any mine, booby-trap or other device which is designed or of a nature to cause superfluous injury or unnecessary suffering.
> . . .
> 7. It is prohibited in all circumstances to direct weapons to which this Article applies, either in offence, defense or by way of reprisals, against the civilian population as such or against individual civilians or civilian objects.
> 8. The indiscriminate use of weapons to which this Article applies is prohibited. Indiscriminate use is any placement of such weapons:
> (a) which is not on, or directed against, a military objective. In case of doubt as to whether an object which is normally dedicated to civilian purposes, such as a place of worship, a house or other dwelling or a school, is being used to make an effective contribution to military action, it shall be presumed not to be so used; or
> (b) which employs a method or means of delivery which cannot be directed at a specific military objective; or
> (c) which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated.
> 9. Several clearly separated and distinct military objectives located in a city, town, village or other area containing a similar concentration of civilians or civilian objects are not to be treated as a single military objective.

Id. art 3. It bears mention that "other devices," defined as manually-placed munitions and devices including improvised explosive devices designed to kill, injure, or damage and which are actuated manually, by remote control, or automatically after a lapse of time, probably does not include nanoweapons.

justly condemned by the general opinion of the civilized world,"[315] and preamble of the CWC affirms that CWC signatories are "determined for the sake of all mankind, to exclude completely the possibility of the use of chemical weapons, through the implementation of the provisions of this Convention, thereby complementing the obligations assumed under the Geneva Protocol of 1925 . . . ."[316] Those statements encapsulate the core of the humanitarian argument against gas weapons from their inception. The reader should be familiar with the basic doctrines of military necessity,[317] proportionality,[318] unnecessary suffering,[319] chivalry,[320] general war crimes,[321] treachery,[322] and general "humanitarian law"[323] against which all new weapons are weighed. They are all relevant to any analysis.

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315. Geneva Protocol, *supra* note 23, pmbl.

316. Chemical Weapons Convention, *supra* note 10, pmbl.

317. *See* MYRES MCDOUGAL & FLORENTINO FELICIANO, LAW AND MINIMUM WORLD PUBLIC ORDER 72 (1961) (defining military necessity as "such destruction, and only such destruction, as is necessary, relevant and proportionate to the prompt realization of legitimate military objectives"). According to the *U.S.M.C. Law of War Deskbook*, its elements include that the force used is (a) capable of being regulated; (b) necessary to achieve enemy submission as soon as possible, and consistent with military security requirements; (c) not greater than needed to achieve enemy submission (in terms of the overall conflict); and (d) is not otherwise prohibited. U.S.M.C. LAW OF WAR DESKBOOK (1992).

318. *See generally* E. THOMAS SULLIVAN & RICHARD S. FRASE, PROPORTIONALITY PRINCIPLES IN AMERICAN LAW (2009).

319. *See, e.g.*, St. Petersburg Declaration, *supra* note 252 (prohibiting in certain instances "the employment of arms which uselessly aggravate the sufferings of disabled men, or render their death inevitable").

320. *See* U.S. DEP'T OF THE ARMY, FIELD MANUAL 27-10: THE LAW OF LAND WARFARE ¶3 A (1956) (requiring that belligerents "conduct hostilities with regard for the principles of humanity and chivalry"). Sir Hersch Lauterpacht comments in *Manual of Military Law, Part III, The Law of War on Land*, that chivalry "demands a certain amount of fairness in offense and defense, and certain mutual respect between the opposing forces." MANUAL OF MILITARY LAW, PART III: THE LAW OF WAR ON LAND 2 (1958).

321. *See, e.g.*, 18 U.S.C. § 2241 (2006) (defining war crimes).

322. *See, e.g.*, ERIC CASTREN, THE PRESENT LAW OF WAR AND NEUTRALITY 194 (1954) (arguing that:"the use of [easily detectable] gas in warfare has had . . . not [yet] been treacherous, [b]ut when and if, as is likely, entirely odorless and invisible poisonous gases are invented, there will be no legal difference between the use of them and other poison."). *But see* Kelly, *supra* note 139 (showing that Castren's position was rejected by state practice).

323. International humanitarian law is "the body of rules applicable in armed conflict which protect those not or no longer taking active part in hostilities [and] regulate permissible means and methods of warfare." ICRC, *Humanitarian Law, Human Rights and Refugee Law—Three Pillars* (April 23, 2005), *available at* http://www.icrc.org/web/eng/siteeng0.nsf/html/6T7G86.

They have also all been more than adequately discussed in the context of chemical warfare.[324]

III. *GOOD FAITH PRINCIPLE OF TREATY INTERPRETATION*

This Part is not intended to be a general treatise on treaty interpretation, or on any particular state's treatment of treaty interpretation law.[325] Rather, it is simply intended to articulate certain agreed-upon principles of good faith interpretation which should inform the application of current treaties to new and developing nanomaterials.[326]

Article 31 of the Vienna Convention on the Law of Treaties provides that "a treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose."[327] The United States signed the Vienna Convention in 1970[328] and voluntarily follows many of its provisions, but it is yet to gain the advice and consent necessary for ratification within the U.S. Senate.[329] Professor Evan Criddle contends that the United States is reluctant to ratify the Vienna Convention because the Supreme Court relies on domestic ratification materials,[330] defers to Executive Branch interpretation, and U.S.

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324. *See* Kelly, *supra* note 139, at 47–52.

325. *See, e.g.*, JOHN NORTON MOORE, TREATY INTERPRETATION, THE CONSTITUTION AND THE RULE OF LAW (2001) (theorizing about treaty interpretation); RICHARD GARDINER, TREATY INTERPRETATION 147–48 (2008) (same); DEVELOPMENTS IN INTERNATIONAL LAW IN TREATY MAKING (Rüdiger Wolfrum & Volker Röben eds., 2005) (same).

326. Hanspeter Neuhold lists four requirements for a treaty to create an effective legal regime: (1) speed; (2) clarity and uniformity; (3) universality of participation; and (4) flexibility and adaptability. *See* Hanspeter Neuhold, *The Inadequacy of Law-Making by International* Treaties, *in* DEVELOPMENTS OF INTERNATIONAL LAW IN TREATY MAKING, *supra* note 325, at 43. Regarding clarity and uniformity, Neuhold notes that a treaty may be ineffective "because its provisions are ambiguous, or because the obligations it imposes are not identical for all parties." *Id.*

327. Vienna Convention, *supra* note 24, art. 31.

328. *See* Status of the VCLT, http://treaties.un.org/pages/viewdetailsiii.aspx?&src=treaty&mtdsg_no=xxiii~1&chapter=23&lang=en (last visited Apr. 3, 2010).

329. *See* Evan J. Criddle, *The Vienna Convention on the Law of Treaties in U.S. Treaty Interpretation*, 44 VA. J. INT'L L. 431, 434 (2004).

330. The Vienna Convention rejects limiting reliance to *traveaux preparatoires*. *See* Vienna Convention, *supra* note 24, art. 32.

courts more broadly tend to construe treaties in light of domestic interests.[331]

While U.S. courts are less likely than courts in many other states to rely solely on international source materials, they still espouse the underlying requirement of good faith treaty interpretation. In *Sanchez-Llamas v. Oregon*, the U.S. Supreme Court specifically relied on the good faith requirement: "[T]he United States ratified the [Vienna Convention on Consular Relations] with the expectation that it would be interpreted according to its terms."[332] The Court has also recognized the good faith requirement in treaties signed with Native American tribes. The Court in *McClanahan v. Arizona State Tax Commission*, for instance, wrote, "It is circumstances such as these which have led this Court in interpreting Indian treaties, to adopt the general rule that '[d]oubtful expressions are to be resolved in favor of the weak and defenseless people who are the wards of

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331. *See* Criddle, *supra* note 329, at 454. Criddle specifically mentions the good faith requirement when discussing *United States v. Alvarez-Machain*, 504 U.S. 655 (1992):

> [A]lthough both the majority and dissent apparently accepted that the Extradition Treaty should be interpreted "in accordance with the ordinary meaning to be given the terms" and consistent with the treaty's overarching "object and purpose," neither seriously considered the Convention's instruction to construe treaties "in good faith." Informing this assessment of "good faith" is Article 31(3)(c)'s additional instruction, which enjoins courts to "take into account . . . [a]ny relevant rules of international law applicable to the relations between the parties." Thus, a "good faith" treaty interpretation would account for "the general principle of international law," discussed in Justice Rehnquist's majority opinion, i.e., "that one government may not 'exercise its police power in the territory of another state." The Vienna Convention incorporates this "general principle" into the Extradition Treaty by implication. Of course, the Vienna Convention's interpretive framework does not operate mechanically, eliminating the need for courts to exercise "good faith" and sound judgment. Instead, the Vienna Convention's function is primarily heuristic [i.e. a "rule of thumb" based on trial and error], channeling courts' reasoning toward a circumscribed range of internationally acceptable treaty constructions.

Criddle, *supra* note 329, at 494–95.

332. Sanchez-Llamas v. Oregon, 548 U.S. 331, 347 (2006) (quoting section 325 *Restatement (Third) of Foreign Relations Law of the United States* as stating that "An international agreement is to be interpreted in good faith in accordance with the ordinary meaning to be given to its terms in their context and in the light of its object and purpose"). Note that section 325 of the Restatement specifically follows article 31 of the Vienna Convention. *Compare* RESTATEMENT (THIRD) OF FOREIGN RELATIONS LAW OF THE UNITED STATES § 325 (1986), *with* Vienna Convention, *supra* note 24, art. 31.

the nation, dependent upon its protection and good faith.'"[333] The most recent word on treaty interpretation by the U.S. Supreme Court is found in *Medellin v. Texas*, where the Court held that an International Court of Justice ruling that a foreign national had not been informed of his rights under the Vienna Convention on Consular Relations did not preempt Texas limitations on filing excessive petitions for habeas corpus.[334] That opinion has occasioned critical commentary relating to treaty interpretation by the Supreme Court.[335]

It is fair to say that the principle of good faith interpretation, and the language of *Restatement (Third) of Foreign Relations Law of the United States*, is relevant in applying the Geneva Protocol and its progeny to nanoweapons. However, in light of past arguments over the meaning of words in chemical-related treaties,[336] the content of the good faith requirement may be a matter of at least some controversy. This very concern informs a cautious approach to any possible ambiguities in international treaties, especially those regulating armed conflict. It is to the possible ambiguities and their application to nanoweapons that this analysis now turns.

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333. 411 U.S. 164 (1973) (quoting Carpenter v. Shaw, 280 U.S. 363(1930)). Also, "courts in the United States are generally more willing than those of other states to look outside the instrument to determine its meaning. In most cases, the United States approach would lead to the same result." RESTATEMENT (THIRD) OF FOREIGN RELATIONS LAW OF THE UNITED STATES § 325 cmt. G (1986); *cf.* United States v. Stuart, 489 U.S. 353, 368 (1989).

334. 552 U.S. 491 (2008).

335. *See, e.g.*, David J.Bederman, *Medellin's New Paradigm for Treaty Interpretation*, 102 AM. J. INT'L L. 529, 539 (2008).("Perhaps what is most notable about the *Medellín* majority's approach to treaty interpretation is the extent to which it eschews formalism. Despite the occasional invocation of "general principles of interpretation," and the broad canon that "'interpretation . . . must, of course, begin with the language of the [t]reaty itself," . . . [n]owhere in the *Medellín* opinions are the most difficult aspects of contemporary treaty interpretation grappled with: When is it appropriate to break from the treaty text? How high should an interpreter's tolerance for ambiguity be? Are all extratextual sources of construction to be treated equally? What intentions matter in treaty interpretation (those of the original treaty drafters or those generated by subsequent practice)? *What role is there for a supervening canon of good faith in treaty interpretation so as to ensure that a selected construction does not result in a material breach of the agreement?*" (emphasis added)). Professor John Moore discusses U.S. Supreme Court jurisprudence on treaty law and makes a compelling argument for rule of law in application of treaties. *See generally* JOHN NORTON MOORE, TREATY INTERPRETATION, THE CONSTITUTION AND THE RULE OF LAW (2001).

336. *See supra* Part II.A.1.d.i.

IV. *GOOD FAITH INTERPRETATION OF CURRENT LAWS APPLICABLE TO NANOMIMICS*

A. *Application of Current Treaties*

Depending on the circumstances, and the nanomaterials involved, it ranges from certain to strongly arguable, but not entirely certain, that the principal treaties at issue here—BWC and CWC with the incorporated Geneva Protocol—apply.[337] The principal difficulty in achieving the absolute predictability for which all law strives[338] is the historic tendency of states to find any available loopholes in wartime; these interpretations of law are rejected by the vast majority of states but still have a certain plausibility. In the last century, there have been two particular examples involving use of gas in arguable violation of existing

337. Pinson, *supra* note 33, argues that because the BWC bans toxins "whatever their origin or method of production," that it therefore "seems to include so-called mechanical devices that could result from mature nanotechnology [and so] one can argue that [a] nanorobot[] can be treated as a toxin if it causes harm similar to other already known toxins." *Id.* at 298. He goes on to recognize a counterargument that the BWC "seems to deal only with biological organisms" and concludes that "[p]erhaps the only way nanotechnology can fall under the BWC's prohibitions without a doubt as if it were used to artificially create exact replicas of known biological weapons or toxins." *Id.* His examination of CWC applicability is equally jejune. He essentially argues that while nanoproducts "may not be chemicals in the sense originally conceived of by the CWC drafters, nanotechnology might still be perceived as a *functional* equivalent and thereby covered under the CWC." *Id.* at 302. Without any in-depth analysis, he concludes that "nano-germs" and "nano-assassins" "could be prohibited as a toxic chemical under the CWC, as they would have no purpose other than causing harm or death to humans or animals." *Id.* Pinson concludes that the BWC and CWC are inapplicable, without mentioning the CWC's applicability to analogous devices under the Geneva Protocol or the most likely scenario where existing chemical products are reduced to nanoscale to defeat defensive systems, and then proceeds to argue for the creation of a new international treaty. *Id.* at 302–09. He argues that "because of the vagueness of the word "chemical," any country can contend that nanotechnology is not chemical and therefore not prohibited." *Id.*

338. *See* Oliver Wendell Holmes, Jr., *The Path of the Law*, 10 HARV. L. REV. 457, 457 (1897) ("The object of our study [of law] is prediction, the prediction of the incidence of the public force through the instrumentality of the courts. The means of study are a body of reports, of treatises, and of statutes . . . [in which] are gathered the scattered prophecies of the past . . . . These are what properly have been called the oracles of the law. Far the most important and pretty nearly the whole meaning of every new effort of legal thought is to make these prophecies more precise, and to generalize them into a thoroughly connected system.").

bans: Germany in World War I and the United States in Vietnam.[339]

Germany's use of gas on a large scale commencing in 1915, the German legal analysis, and the ensuing argument regarding violation of the Hague ban, has been discussed above.[340] As Haber notes, Germany "argued at the time and later, that (i) the Conventions did not cover gas blown from cylinders, (ii) the Allies had used gas first, (iii) gases were not poison, and (iv) after the war, gas shells were implicitly excluded because they were not causing needless suffering . . . ."[341] There were certainly ambiguities in the then-existing treaties and all sides mercilessly exploited them.[342] However, the German case is not the only instance of a technical legal argument exploiting treaty ambiguity to justify the use of gas in an armed conflict. The United States adopted the same approach with respect to its use of tear gas during the Vietnam War.[343]

In some ways, the U.S. argument regarding tear gas in Vietnam was an even further stretch than Germany's in World War I: First, the treaty drafters' intent in 1925 seems considerably clearer than the general principles espoused at the Hague Conventions prior to World War I.[344] Second, there was even more general agreement among major powers that tear gas was

339. *See supra* notes 131, 222 and accompanying text. Germany still has a valid claim that the Allies used some sorts of gas before 1915. *See supra* notes 132–35 and accompanying text. Whether those gases were toxic or asphyxiating remains open to debate. *See, e.g.*, *supra* note 137 and accompanying text. The Allies certainly used banned gases after 1915 in reprisal.

340. *See supra* Part II.

341. HABER, *supra* note 113, at 19.

342. Among the interpretative questions were (1) whether "asphyxiating" applied to gases that worked through other means such as skin absorption; (2) whether "poison" included non-lethal or allegedly non-lethal weapons; (3) whether release of gas from cylinders was within the coverage of the ban on "projectiles;" and (4) whether fine powders were considered gases if they had the same effect. *See supra* Part II.

343. *See supra* note 222; *see also* John Norton Moore, *Ratification of the Geneva Protocol on Gas and Bacteriological Warfare: A Legal and Political Analysis*, 58 VA. L. REV. 419, 444–47 (1972) (discussing the U.S. belief that tear gas and herbicides were acceptable under the Geneva Protocol).

344. *See* Alice I. Youmans et al., *Questions and Answers*, 83 LAW LIBR. J. 195, 202 (1991) ("[T]he 1925 Protocol was more comprehensive than previous agreements."); *see also* Florencio J. Yuzon, *Deliberate Environmental Modification Through the Use of Chemical and Biological Weapons: "Greening" the International Laws of Armed Conflict to Establish and Environmentally Protective Regime*, 11 AM. U. J. INT'L L. & POL'Y 793 (1996) (discussing that the Geneva Protocol specifically expanded the prohibitions contained in prior agreements).

banned as a weapon of war.[345] Importantly, however, the United States did not ratify the Geneva Protocol until after the end of its participation in the Vietnam War,[346] and tear gas on its own was much less noxious than other chemical weapons.[347] Nevertheless, given the general U.S. attachment to the English language, there is a certain air of unreality in basing its argument on the French language version of the Geneva Protocol.[348] In any case, both examples demonstrate that it is wise to closely read any treaty purporting to govern new weapons technology.

1. Application to Nanoparticles

Certainly, the treaties are applicable to nano-sized particles of substances covered by existing conventions. The CWC by its language applies to "toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes."[349] A toxic chemical is "any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals."[350] Most importantly, "[t]his includes all such chemicals, *regardless of* their origin or of *their method of production*, and regardless of whether they are produced in facilities, in munitions or elsewhere."[351]

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345. *See* Bunn, *supra* note 222, at 395, 403.

346. *See supra* note 22 and accompanying text. The United States ended its combat involvement in Vietnam in 1973. *See* SAMUEL LIPSMAN & STEPHEN WEISS, THE VIETNAM EXPERIENCE: THE FALSE PEACE 1972–74 (1985).

347. *See* TUCKER, *supra* note 42, at 4, 11, 195. Though tear gas itself was less harmful than other chemical weapons, it was used to drive enemy troop out of protective bunkers and caves so they could be captured or killed by lawful means. *See id.* at 223.

348. *See supra* note 167 and accompanying text.

349. Chemical Weapons Convention, *supra* note 10, art II(1)(a).

350. *Id.* art. II(2)

351. *Id.* (emphasis added). The CWC also provides that "a toxic chemical or precursor should be included in Schedule 1 [if it] has been developed, produced, stockpiled or used as a chemical weapon as defined in Article II." *Id.*, Annex on Chemicals, sec. A(1). The CWC also subjects "chemicals listed in Schedule 1 . . . to the prohibitions on production, acquisition, retention, transfer and use as specified in Part VI of the Verification Annex." *Id.*, art. VI. Part VI of the Verification Annex further requires that parties to the CWC

> not produce, acquire, retain or use Schedule 1 chemicals outside the territories of States Parties and shall not such chemicals outside except to another State Party[, and] . . . the types and quantities of chemicals are strictly limited to those which can be justified for such purposes; and . . . the

It is clear that the CWC bans any existing or future chemical weapons, including nano-sized particles, that are asphyxiating, vesicant, nerve agents, or lachrymatory, regardless of the physical form that they take (i.e. gas, liquid, solid), unless they fall into one of the CWC's enumerated exceptions.[352] Although the actual physiological effects of nano-sized particles of a banned substance might be different and are probably more severe, the chemical content remains the same; such material unquestionably falls within the relevant schedules.[353] The same absolute ban also applies to nano-enhanced delivery systems of such materials.

2. Application to Nano Delivery Systems

Cancer researchers "now use nanoscale devices as drug delivery vehicles."[354] That nanoscale devices can deliver toxic chemicals to specific cells in such sufficient quantities should immediately raise concerns about the use of nanotechnology to deliver banned chemical weapons. It is clear, though, that the CWC, which covers the toxic content of these carriers, should also cover these delivery devices.

The CWC provides that "'Chemical Weapons' means the following, together or separately: . . . (b) Munitions and devices, specifically designed to cause death or other harm through the toxic properties of . . . toxic chemicals . . . which would be released as a result of the employment of such munitions and

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> aggregate amount of such chemicals at any given time for such purposes is equal to or less than 1 tonne; and . . . the aggregate amount for such purposes acquired by a State Party in any year through production, withdrawal from chemical weapons stocks and transfer is equal to or less than 1 ton.

Id., Annex on Implimentation and Verification, pt. VI(A)(1)–(2).

352. The CWC drafters defined chemical weapons so broadly in order to prohibit possession of all known, unknown, and future toxic chemicals, in types and quantities that cannot be justified for permitted purposes. For this reason, the chemical weapons definition captures both novel and traditional chemical agents. *See Chemical Weapons Convention: Hearing on Treaty Doc. 103-21 Before the Comm. on Foreign Relations,* 103d Cong. 37 (1994) (statement of J. Stephen Ledogar, U.S. Rep. to the Conference on Disarmament, U.S. Dep't of State).

353. *See* Chemical Weapons Convention, *supra* note 10, Annex on Chemicals.

354. *See* Press Release, Yale University Office of Public Affairs, Yale University Office of Public Affairs Describes Study That Uses Nanoparticle for Delivery of Prostate Cancer Treatment (Mar. 27, 2007), *available at* http://opa.yale.edu/news/article.aspx?id=2061.

devices . . . ."[355] Devices designed to cause death or other harm through release of toxic chemicals is a clear description of nano delivery systems when used to deliver banned substances. That coverage is unquestionable when compared and contrasted with the 1925 Protocol which is incorporated into the CWC.

The Geneva Protocol bans "asphyxiating, poisonous or other gases and . . . all analogous liquids, materials or devices."[356] As was demonstrated above, the "analogous device" language in the Geneva Protocol springs from the original drafters' concern with asphyxiating and toxic materials other than gas.[357] Its inclusion in the CWC, along with the specific ban on "'[m]unitions' and 'devices' [that release] toxic chemicals," represents explicit recognition that (1) such devices needed to be separately banned and (2) the Geneva Protocol's prohibition on analogous devices dealt with something other than delivery systems.[358]

The CWC undeniably bans nanodevices designed to cause death or other harm through the release of toxic chemicals, except in certain limited circumstances. Inevitably, many of these devices have the capability of serving both innocent and dangerous functions.[359] But the CWC indisputably does not ban nanodevices that operate within legal parameters.[360]

Even in light of the analysis presented thus far in this Article, a principal issue remains: do the relevant conventions—CWC, BWC, and the Geneva Protocol incorporated into both—taken together act to absolutly ban the production and use of nano-sized devices that can mimic banned chemicals, microbial or other biological agents, or toxins? Are "nanomachines . . .

355. Chemical Weapons Convention, *supra* note 10, art. II. Note that article 1 of the BWC contains a similar ban on "[w]eapons, equipment or means of delivery designed to [Microbial or other biological agents, or toxins] use [them] for hostile purposes or in armed conflict." *See* Biological Weapons Convention *supra* note 13, art. I(2).

356. Geneva Protocol, *supra* note 23.

357. *See supra* Part II.A.

358. Chemical Weapons Convention, *supra* note 10, art. I.

359. *See id.*, art. II.

360. *See supra* note 267 and accompanying text. There is no legitimate argument that the exception does not extend to delivery devices like agricultural sprayers, which have been used to deliver chemical weapons. *See* MICHAEL KEANE, DICTIONARY OF MODERN STRATEGY AND TACTICS 35 (2005).

chemical weapons under the . . . Chemical Weapons Convention"?[361]

3. Application to Nanomimics

It is highly likely that the CWC, BWC, and Geneva Protocol together apply to nano-sized mechanical mimics. The arguments for their coverage are not just persuasive; in the Author's opinion they are so compelling that any attempt to avoid their coverage would rise to the level of breaching requirement of good faith interpretation.

The arguments for their coverage consist of the following factors: (1)the Geneva Protocol drafters' intent; (2) the CWC and BWC drafters' intent; (3) textual comparison of the three conventions; (4) that all of these weapons cause a chemical or biological reaction; and (5) international law's good faith requirement with respect to treaty interpretation. Each argument is independently compelling, but taken together they are overwhelming.

a. Drafters' Intent in the Geneva Protocol

As discussed above, the language of the Geneva Protocol was taken directly from the Treaty of Versailles, and the Washington Submarine Treaty was specifically informed by the existence and effective use of chemical weapons other than gases in World War I.[362] It is clear that the drafters were aware of the problems caused by fine particles capable of passing through protective masks that neutralize gases, recognized the distinction between "processes" and "devices" but deliberately chose to describe actual toxic weapons as devices, and were fully capable of including—and did include—a delivery device as a separate banned weapon where they thought it appropriate.[363] It therefore

361. MCGUINNESS, *supra* note 3, at 27.

362. *See* BERNAUER, *supra* note 147.

363. *See supra* Part II.A. Hence, we see the inclusion of "flammenwerfer" in several of the post-World War I treaties. *See supra* notes 164–66. Note that a flamethrower is a device for delivering burning fuel, Dewar *supra* note 166, at 47–48, and that a later ban of incendiary weapons paints in broad definitional strokes "any weapon or munition which is primarily designed to set fire to objects or to cause burn injury to persons through the action of flame, heat, or combination thereof, produced by a chemical reaction of a substance delivered on the target" (thought it also includes a specific

becomes clear that the decision to include and retain "analogous devices" alongside the ban on poisonous and asphyxiating gases was a deliberate ban on wartime use of any weapon analogous to asphyxiating or toxic gases. Nanomimics are precisely analogous to poisonous and asphyxiating gases[364] and the Geneva Protocol's incorporation into later conventions and treaties—particularly the CWC and BWC—strengthens this argument.

b. Drafters' Intent in the CWC and BWC

The CWC negotiations were long and detailed,[365] in part because the negotiators were specifically concerned with avoiding both evasive conduct and outright cheating.[366] As a result, the CWC contains broad, specific, positive, and negative requirements; a mechanism for continued verification of compliance; and analysis of possible new violations.[367]

Given the high levels of distrust during the Cold War, it was probably inevitable that interim confidence building measures and bilateral treaty negotiations were necessary to achieve what eventually became the CWC.[368] The long negotiations and interim steps, however, resulted in a treaty providing comprehensive coverage, including prohibition of new research

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reference to flamethrowers as exemplary of the type). Conventional Weapons Convention, *supra* note 164, Protocol III art. 1(1).

364. *See supra* Part I.D.

365. *See* Chronology of Chemical Weapons Negotiations at the Conference on Disarmament, http://dosfan.lib.uic.edu/acda/factshee/wmd/cw/cwcneg.htm (last visited Apr. 3, 2010).

366. *See* ROBINSON, *supra* note 228, at 17–36.

367. *See generally* Chemical Weapons Convention, *supra* note 10.

368. The United States and Russia engaged in diplomatic negotiations prior to signing the CWC:

> the Presidents noted that cooperation between the two countries in the prohibition of chemical weapons has enabled both countries to enhance openness regarding their military chemical potential and to gain experience with procedures and measures for verifying compliance with the Chemical Weapons Convention. The Parties will continue cooperation between them in chemical disarmament

Russia-United States Joint Statement on Chemical Weapons, 33 WEEKLY COMP. OF PRES. DOC, 391 (Mar. 21, 1997).

and development.[369] They also created an ongoing international body to monitor new developments and means of production.[370]

The BWC is considerably less detailed than the CWC but its coverage is at least as broad.[371] Its core is found in article 1, which provides in its entirety:

> Each State Party to this Convention undertakes *never in any circumstances to develop*, produce, stockpile or otherwise acquire or retain:
>
> (1) *Microbial or other biological agents, or toxins* whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;
>
> (2) *Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.*[372]

While there has been some "push back" in later negotiations from states concerned that BWC interpretation might interfere with legitimate research,[373] general consensus has emerged in favor of absolute bans on *any* new biological weapons in whatever form they might emerge.[374] The negotiating history of the BWC

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369. *See* Chemical Weapons Convention, *supra* note 10, art. I. ("Each State Party to this Convention undertakes *never under any circumstances: (a) to develop* [or] produce . . . chemical weapons.").

370. *See generally* Chemical Weapons Convention, *supra* note 10, art. VIII(A).

371. *See generally* Biological Weapons Convention, *supra* note 13. In one aspect, the BWC is more detailed than the CWC in that it specifically provides that

> nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the 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 June 17, 1925

Id. art. XIII.

372. *Id.* art. I. (emphasis added). As with the CWC, there is a national implementation provision:

> [E]ach State Party to this Convention shall, in accordance with its constitutional processes, take any necessary measures to prohibit and prevent the development, production, stockpiling, acquisition, or retention of the agents, toxins, weapons, equipment and means of delivery specified in article I of the Convention, within the territory of such State, under its jurisdiction or under its control anywhere.

Id. art. IV.

373. *See, e.g.*, MALCOLM R. DANDO, PREVENTING BIOLOGICAL WARFARE: THE FAILURE OF AMERICAN LEADERSHIP 171–80 (2002) (detailing the Bush administration's rejection of the Verification Protocol at the Fifth Review Conference).

374. The most recent review conference of the BWC produced a final document with the following statements:

was considerably less complex than that of the CWC, and in essence sprang from a two state consensus between the United States and the U.S.S.R. in the 1970s[375] and a general recognition that biological weapons "presented less intractable problems."[376]

The result was a treaty that paints its coverage in very broad strokes, even though it does not contain the rigorous

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1. The Conference reaffirms the importance of Article I, as it defines the scope of the Convention. The Conference declares that the Convention is comprehensive in its scope and that all naturally or artificially created or altered microbial and other biological agents and toxins, as well as their components, regardless of their origin and method of production and whether they affect humans, animals or plants, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes, are unequivocally covered by Article I.

2. The Conference reaffirms that Article I applies to all scientific and technological developments in the life sciences and in other fields of science relevant to the Convention.

3. The Conference reaffirms that the use by the States Parties, in any way and under any circumstances, of microbial or other biological agents or toxins, that is not consistent with prophylactic, protective or other peaceful purposes, is effectively a violation of Article I. The Conference reaffirms the undertaking in Article I never in any circumstances to develop, produce, stockpile or otherwise acquire or retain weapons, equipment, or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict in order to exclude completely and forever the possibility of their use. The Conference affirms the determination of States Parties to condemn any use of biological agents or toxins for other than peaceful purposes, by anyone at any time.

Sixth Review Conference of the States Parties to the BWC, Geneva Switz., Nov. 2–Dec. 8, 2006, *Final Document*, at 9, U.N. Doc. BWC/CONF.VI/6 (2006)

375. *See* Jenni Rissanen, *Issue Brief: The Biological Weapons Convention*, NUCLEAR THREAT INITIATIVE, Mar. 2003, http://www.nti.org/e_research/e3_28a.html (outlining the history leading up to the drafting of the BWC).

376. U.S. Dep't of State, *Narrative on the BWC* (n.d.), *reprinted in* THOMAS GRAHAM, JR. & DAMIEN J. LAVERA, CORNERSTONES OF SECURITY: ARMS CONTROL TREATIES IN THE NUCLEAR ERA 192 (2003) ("An issue that long hindered progress was whether chemical and biological weapons should continue to be linked. A British draft convention . . . concentrated on the elimination of biological weapons only . . . . The United States supported the British position and stressed the difference between the two kinds of weapons. Unlike biological weapons, chemical weapons had actually been used in modern warfare. Many states maintained chemical weapons in their arsenals to deter the use of this type of weapon against them, and to provide a retaliatory capability if deterrence failed. Many of these nations, the United States pointed out, would be reluctant to give up this capability without reliable assurance that other nations were not developing, producing, and stockpiling chemical weapons. While the United States did not consider prohibition of one of these classes of weapons less urgent or important than the other, it held that biological weapons presented less intractable problems, and an agreement on banning them should not be delayed until agreement on a reliable prohibition of chemical weapons could be reached.").

enforcement mechanisms of the CWC. The ban on "microbial or other biological agents, or toxins,"[377] together with their means of delivery, covers all new genetic development and manipulation of potential living weapons and their products.[378] Taken together with the CWC, this regime was certainly intended to broadly cover the development of new chemical and biological weapons. That is even more apparent when their text is compared and contrasted.

c. Textual Comparison of the Three Treaties

A brief comparison of the treaty texts among the Geneva Protocol, BWC, and CWC supports the argument for a very wide breadth of coverage. Among the contracting parties the Geneva Protocol constitutes a "prohibition of . . . the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids materials or devices [and] use of bacteriological methods of warfare."[379] The BWC's major leap was, of course, banning development, production, or possession of an entire class of weapons, not just limiting its prohibition to uses in war.[380] Of key import here is the agreement "*never to develop* [*biological weapons*] *whatever their origin or method of production*,"[381] nor to develop "equipment or means of delivery designed to use such agents or toxins."[382] Taken together, the language of the Geneva Protocol and BWC cover a multitude of weapons and situations in wartime. It took another twenty years, however, for the CWC to close the circle on possession and development of chemical weapons.

In addition to incorporating the Geneva Protocol,[383] the CWC covers three key areas relating to this Article's analysis: (1) banning development, production, and possession of chemical weapons;[384] (2) defining chemical weapons to include delivery

377. Biological Weapons Convention, *supra* note 13, art. I.

378. *See id.* art. VI.

379. Geneva Protocol, *supra* note 23.

380. Biological Weapons Convention, *supra* note 13, art. I.

381. *Id.*

382. *Id.* art. IV.

383. *See supra* notes 22, 112.

384. *See supra* note 266. Each state party also agrees to destroy such weapons and their production facilities. *See supra* note 266.

systems;[385] and (3) clarifying that peaceful development of, *inter alia*, pharmaceutical, medical, and agricultural chemicals, is not impacted.[386] Of key importance here is the definition of "Toxic Chemical:"

> any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals. This includes all such chemicals, regardless of their origin or of their method of production, and regardless of whether they are produced in facilities, in munitions or elsewhere.[387]

This definition certainly covers any toxic chemical, whatever its dosage, as long as it "can cause" any of the effects listed.[388] Taken together with the ban on ". . .devices, specifically designed to cause death or other harm through the toxic properties of those toxic chemicals[,]"[389] there can be no honest argument that the CWC on its face does not cover banned chemicals in nano dosages, and nano sized delivery systems of such chemicals.

The only possible open question is the coverage of speculative nanobots. And yet, both the BWC and CWC incorporate the Geneva Protocol and its ban on the use of "analogous devices" in war.[390] Must one fall back on that language as prohibiting use but not possession? There are two arguments which may take this question past that point to a complete ban. The first is that a common factor of all the nanoweapons discussed here is their effects on the human target.

d. Commonality of Chemical and/or Biological Reactions

All of the nanoscale weapons discussed in this Article eventually directly affect a human target through biological or chemical processes.[391] At the nanoscale, there is considerable

385. *See supra* note 355

386. *See supra* note 267.

387. Chemical Weapons Convention, *supra* note 10, art. II(2).

388. *Id.*

389. *Id.* art. II(1)(b)

390. *See* Geneva Protocol, *supra* note 23, pmbl.

391. It is, of course, possible to posit nanoscale weapons which only indirectly affect humans by, for example, damaging other animals, machines or plants. For example, using emergence technology, simple nanoscale bots could swarm onto all ball bearings in a specified geographic area, effectively shutting down most mechanical systems. Such weapons are simply beyond the scope of this Article.

cross-over among chemistry, biology, and physics.[392] To the extent that the hypothetical nanobot in the AEPI's scenario[393] interacts in the human body at a cellular level in a way designed to mimic a toxic chemical, biological weapon, or toxin,[394] it seems functionally indistinguishable from the substances and materials banned in the treaties discussed above.

The real question is whether such functional equivalence is sufficient as a matter of international law[395] to ban states party to the treaties from developing, possessing, or using nanomimics. That is largely a matter of good faith.

e. Good Faith Requirement for Treaty Interpretation

A good faith requirement in interpretation of treaties is central to international law.[396] The Vienna Convention's requirement of interpretation "in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose"[397] seems particularly relevant to attempts to avoid weapons bans by building a device to mimic a banned chemical or toxin. Even the following problematic approaches that states have taken to avoid treaty bans do not represent the actual creation of a killing device to function identically to an admittedly banned weapon: Germany's arguments that the Hague Convention banned the release of asphyxiating gases from artillery shells but not from cylinders, and the U.S. argument that the French language version of the Geneva Protocol and its predecessor trumped the

392. *See supra* notes 13–14 and accompanying text.

393. *See supra* note 3.

394. Several informed persons have argued to the Author that for the foreseeable future, only engineered viruses would be able to behave in this way. Viruses are not, of course, living things, and yet the BWC clearly covers their development, possession or and use as weapons. If engineered viruses are, in fact, the only entities capable of behaving this way, it is indisputable that the BWC applies to these nanobots. If other forms of nanobots become feasible or foreseeable, a different analysis will apply.

395. In some instances international law recognizes the doctrine of functional equivalence. *See, e.g.*, David Marcus, *Famine Crimes in International Law*, 97 AM. J. INT'L L. 245, 262–64 (2003) (arguing that international law should extend to man-made famines since "famines are often functionally equivalent to genocide").

396. *See supra* Part III.

397. Vienna Convention, *supra* note 24, art. 31.

English language version to create an ambiguity that allowed for use of tear gas in war.[398]

If the good faith requirement is to have any validity at all in international law, it must apply to ban the use of nanomimics as weapons. Given states' past attempts to evade existing bans, it is still appropriate at least to consider pursuing past proposals for new treaties implementing new bans, and to considering clarifying the pertinent treaties through minor modification.

B. *Is There A Need For A New Convention?*

Several authors have discussed drafting new conventions or modifying the CWC and BWC.[399] In an interesting article that unfortunately ignores some of the fundamental approaches to understanding the law of armed conflict, Sean Howard suggests that there are only "two basic options for designing a possible arms control approach to the mass-destructive potential of nanotechnology:" (1) to create a "regime of control and restraint" over the technology; or (2) to totally ban the technology.[400] Howard suggests "a rough transposition of the Outer Space Treaty [to seek] peaceful exploitation . . . of the nanosphere."[401] But Howard seems to ignore possible alternative arms control and technology models—most obviously the CWC—and the possibility of simply modifying existing conventions. Indeed, simply modifying the BWC and CWC might be the easiest course of action.

Jurgen Altmann suggests that while changing the wording of the CWC might be difficult, it would be useful to clarify that "[t]oxic substances that are not of biological origin or are not produced by biological systems would not count as toxins, but would fall under the CWC, i.e. be prohibited if directed against humans or animals."[402] Altman also suggests "preventive arms control" in the form of technology limits.[403] This approach seems flawed, given general resistance to absolute technology limits,[404]

398. *See supra* notes 131, 222.

399. *E.g.*, Pinson, *supra* note 33, at 302–09 (advocating the need for a new treaty); Trapp, *supra* note 11, at 2 (noting that modifications to the CWC may be necessary).

400. *See* Howard, *supra* note 59.

401. *See id.*

402. Altmann, *supra* note 36, at 171–72.

403. *Id.* at 123–24.

404. *See, e.g.*, Chemical Weapons Convention, *supra* note 10, art. VI.

and the United States' specific opposition to limits on potential nanotechnology developments.[405]

In his discussion of a regulatory approach, Reynolds suggests a number of useful approaches, including building "inherent safety" into any living nanotech product through "genome encryption."[406] Many of his suggestions closely follow the Foresight Guidelines articulated by the Foresight Institute, which studies and discusses nanotech issues.[407] While the Foresight Institute makes certain leaps of scientific faith[408] about the potential problems, from an academic view, their solutions are well-conceived on a national basis. They do not, however, approach the weapons regulation problem in a way the Author considers viable in the current international legal system; they will not limit willing proliferators. The Foresight Institute recognizes that possibility:

> Adding particular weapons related applications of MNT [molecular nanotechnology] to the list of technologies covered in Chemical, Biological and Nuclear Weapons treaties may be appropriate in certain cases. It should be remembered, however, that the capabilities of productive nanosystems will be extensions of general manufacturing technology. The military applications of MNT will include the manufacture of high performance aerospace vehicles and precision munitions at low cost. The high value and dual use of MNT for civilian and defense purposes will require making distinctions between the enabling technology and its specific applications, balancing health and economic benefits against security concerns. Since nanotechnology research is now global, the security challenges will be present, with or without the ability to capture the wide variety of benefits.

405. *See generally* OFFICE OF SCI. & TECH. POLICY, DOMESTIC POLICY COUNCIL, AMERICAN COMPETITIVENESS INITIATIVE: LEADING THE WORLD IN INNOVATION (2006). Indeed, given the speed with which technology is changing, it seems best to make limiting language as broad as possible which the drafters of the original conventions certainly did intentionally.

406. *See* Reynolds, *supra* note 59, at 203.

407. *See* Neil Jacobstein & Glenn Harlan Reynolds, Foresight Inst., *Foresight Guidelines 4.0: Self Assessment Scorecards for Safer Development of Nanotechnology* (Oct. 2004), *available at* http://www.foresight.org/guidelines/2004oct.html.

408. *See, e.g.*, Smalley, *supra* note 46, at 1.

> Overly restrictive treaties or regulatory regimes applied to core MNT technologies could lead to the unintended consequence that only the rule-following nations would be at a competitive disadvantage technologically, economically, and militarily. While most nations, companies, and individuals are likely to adhere to reasonable safety restrictions, guidelines that are viewed as too restrictive will simply be ignored, paradoxically increasing risk. In addition, not all guidelines and laws will be followed, and enforcement is rarely perfect. Non-state actors could become quite significant, particularly when the relevant knowledge and raw materials are available globally. They may well not be signatories to any agreement. While a 100% effective ban could, in theory, avoid the potential risks of certain forms of molecular nanotechnology, a 99.99% effective ban could result in development and deployment by the 0.01% that evaded and ignored the ban. For example, the international Biological Weapons Treaty was being violated on a massive scale even before the ink was dry.[409]

The Foresight Institute and others miss the essential point—that the BWC and CWC, taken together and in light of their incorporating the Geneva Protocol, almost certainly do cover the sorts of nanodevices with which the Foresight Institute is most concerned.[410] Drafting an entirely new treaty is unnecessary, and would waste time and effort. Nevertheless, these concerns are legitimate and worth considering.

There is no real need for specific language changes to the BWC and CWC. However, if history serves as any guide, the CWC's section of definitions could clarify the intent to include nanomimics or other nanobots; the BWC would not require more than one or two additional words in its prescriptions to clarify its intent. As long as the intent is made clear enough to avoid evasion of already existing coverage of nanomimics, the wording can be flexible.

Under one possible approach, article 2 of the CWC could be modified. The revised CWC would read as follows:

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409. *See* Neil Jacobstein, Foresight Inst., *Foresight Guidelines for Responsible Nanotechnology Development* (Apr. 2006), *available at* http://foresight.org/guidelines/currentguidelines/current.html.

410. *See supra* Part II.

> 1. "Chemical Weapons" means the following, together or separately: (a) Toxic chemicals *or their equivalents including any analogous devices* and their precursors *or their equivalents including any analogous devices*, except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes.[411]

Under a similar approach, article 1 of the BWC could be modified. The revised BWC would the read:

> [E]ach State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain: (1) Microbial or other biological agents, or toxins, *or their equivalents including any analogous devices* whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes.[412]

Such changes are superfluous given the Geneva Protocol's incorporation into both the BWC and CWC. Accordingly, the actual wording and placement of any changes are largely immaterial; more important is that any new language clarify that the intent of the states party is to prevent any evasion of the prohibition on devices and materials analogous to banned weapons, and that their use in war remain forbidden regardless of their shape and form.

CONCLUSION

The Great War changed the world in ways unparalleled before 1918. Although some earlier wars had global reach, three factors at play in World War I created a new reality of mass-involvement: (1) advances in science and communications;[413] (2) global participation;[414] and (3) total mobilization.[415] The concomitant result of that mass mobilization, however, was almost universal war weariness when the guns were silenced.[416] The revulsion caused by war, especially by the chemical warfare

411. *Cf.* Chemical Weapons Convention, *supra* note 10, art II.

412. *Cf.* Biological Weapons Convention, *supra* note 13, art. I.

413. *See* JOHN W. OLIVER, HISTORY OF AMERICAN TECHNOLOGY (1956).

414. *See generally* THE GREAT EVENTS OF THE GREAT WAR (Charles Horne ed., 1920).

415. *See* H.P. WILLMOTT, WORLD WAR I 131 (Dorling Kindersley ed., 2003).

416. *See generally* ROBERT ELSON, PRELUDE TO WAR (1977); STANLEY WEINTRAUB, A STILLNESS HEARD ROUND THE WORLD: THE END OF THE GREAT WAR: NOVEMBER 1918 (1985).

that was utilized, translated almost inexorably into state policy and international law.[417] Much of the following decade's lawmaking was lost in the economic devastation and cultural insanity of the 1930's, but the absolute ban on use of chemical weapons essentially held its own.[418]

The foresight of those who drafted the initial ban on "analogous devices" at Versailles now seems almost accidental and providential, but, in fact, the language was created by hard-headed men based on hard experiences and hard science.[419] The development of the ban, its culmination in the Geneva Protocol, and its incorporation into the BWC and CWC, leave no genuine room for play in any sort of legitimate, good faith argument about nanomimics, and none whatsoever for any other type of chemical or biological nanoweapons.

As a matter of practical science and governing international law, there is really no justifiable argument that any of these potential nanoweapons are uncovered by existing law; but it would certainly do no harm to modify both the BWC and CWC to include supplementary language making clear that the states parties intend to cover all new forms of analogous weapons. In fact, that just might do the world some good.

417. *See supra* Part II.

418. *See supra* Part II.

419. *See supra* Part II.A. Victor Lefebure commented in 1921 that "if sub-atomic forces can eventually be harnessed for war they must be subjected to the same control and attempts at suppression during their development stages." Lefebure, *supra* note 195. Although Lefebure made this comment in the context of nuclear weapons, it still represents the sort of amazingly broad thinking in which chemical warfare experts were engaged at the end of World War I.