Chemistry and Diplomacy: Science Education and Science Communication in Disarmament

Jonathan E. Forman
Science Policy Adviser, Office of Strategy and Policy
Organisation for the Prohibition of Chemical Weapons
jonathan.forman@opcw.org

Figure 1: Online resources available from www.opcw.org and OPCW social media accounts; this figure is interactive with hyperlinks to the indicated materials and information.
Abstract

Science plays a critical role in international disarmament policy and diplomacy; it informs negotiation of international agreements and underpins the key provisions that define the mechanisms of treaty implementation. From an outside view, the world of international disarmament appears to be driven by diplomats and policy makers, not scientific experts; yet, to be effective, disarmament treaties require a sound science and policymaker partnership. Such a partnership must overcome challenges to communication and trust (much like the partnerships between States Parties to international treaties), begging the question, how can this work? It requires clear science communication and engagement between the two perspectives – scientists providing analytical thinking and technical assessments to policy makers, who in turn provide global perspectives on the role and need for science in their work.

Exemplifying the need for scientific (and specifically chemistry) expertise in diplomacy is the Chemical Weapons Convention (CWC), an international disarmament treaty that completely prohibits an entire class of weapons of mass destruction. The implementing body for the CWC, the Organisation for the Prohibition of Chemical Weapons (OPCW), bridges the gap between policy makers and scientific experts through its Scientific Advisory Board and a variety of science communication initiatives. Such initiatives include “Science for Diplomats” briefings and informal science and technology newsletters that are both accessible to non-technical audiences and provide useful links to informative technical publications. We describe here the role of science in disarmament and look at some of the materials and resources made available to scientific and diplomatic communities alike through the OPCW website (Figure 1).

Introduction

History is rich with examples of “game-changing” scientific discoveries with both positive and negative societal and political impact. Science brings forward beneficial changes to the way we live and work; technological advances provide opportunities for economic development; and in a world concerned about sustainability, climate change, and supporting a planet with more than seven billion human inhabitants - advice requiring inputs from scientific experts, has never been more important. Studying science on its own, however, may not be enough to prepare an individual to effectively bring their scientific expertise into the realm of policy and world affairs – an effort that requires understanding and awareness of policy needs and consequences of science, and the ability to effectively communicate science to decision makers (whose educational backgrounds and experience are likely to lie outside of scientific disciplines).1

Looking across the broad spectrum of policy and diplomacy with strong scientific dimensions, international efforts for the disarmament of weapons of mass destruction (WMD) nicely highlight the critical need for scientific expertise in an international political endeavor. Disarmament provides examples of the intersection of science and diplomacy that might prompt science students to explore how the subject they study finds its way into global initiatives. Disarmament lends itself to introducing students to the intricacies and nuances of effectively informing and communicating science to decision makers; people who must balance a complex set of technical and non-technical inputs in their work (and students will inadvertently be exposed to similar circumstances in their post-educational work experiences, regardless of the sector in which they build professional careers). In this regard, the Chemical Weapons Convention (CWC),2 an international disarmament treaty banning chemical weapons, could serve as a subject matter example; perhaps inspiring chemistry students to consider using their scientific training to bring technical insight into the realm of policy and diplomacy.
The Chemical Weapons Convention and the OPCW

Opened for signature in 1993, the CWC entered into force on April 29, 1997, with eighty-seven States Parties (The nations supporting the treaty); today there are 192 States Parties, the most recent being Angola, as of 16 October 2015 (see Figure 2). Along with the CWC, there are two other widely recognized (and in-force) international treaties regulating disarmament and nonproliferation of WMDs, these being the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT, 191 States Parties)\(^3\) and the 1972 Biological Weapons Convention (BWC, 173 States Parties).\(^4\)

![States Parties to the Chemical Weapons Convention](image)

**Figure 2:** States Parties to the Chemical Weapons Convention. As of 16 October 2015, four states remain not party to the CWC: Democratic People's Republic of Korea, Egypt, Israel (signed, but not ratified) and South Sudan.

The CWC was designed to eliminate an entire category of weapons of mass destruction by prohibiting the development, production, acquisition, stockpiling, retention, transfer, or use of chemical weapons by States Parties; all under strict international verification. The States Parties are obligated to enforce this prohibition within their jurisdiction, including destroying chemical weapon stockpiles that they possess. Implementation revolves around a verification regime, agreed to by the States Parties, that allows international chemical weapons inspectors to verify the destruction of military stockpiles and to inspect chemical production facilities (including commercial facilities) meeting certain criteria within their territories. Can you imagine international chemical weapons inspectors visiting the very same commercial chemical production facilities where some of today’s chemistry students might ultimately find employment? This actually happens, with the consent of the governments of the territories where such facilities are located, across the States Parties. In 2014 nearly 3000 days of chemical weapons inspector time was spent visiting industrial facilities!\(^5\) The Organization for the Prohibition of Chemical Weapons (OPCW), the recipient of the 2013 Nobel Peace Prize "for its extensive efforts to eliminate chemical weapons",\(^6\) oversees this verification mechanism as the implementing body for the CWC.
There are four areas of focus in CWC implementation as illustrated in Figure 3: destruction of chemical weapons; non-proliferation and the prevention of re-emergence of chemical weapons (this includes verification activities such as declarations, inspections and investigations); capacity building and training in assistance and protection; and promoting international cooperation in the peaceful use of chemistry for economic and technological development (implemented through a series of capacity building programmes\(^7\)). All of these focal areas require that the science of chemistry be an integral part of treaty implementation. A requirement that demands the OPCW interact with the greater chemistry community; place priority on education and engagement to raise awareness of its work and the contributions both from and to science in chemical disarmament; and a requirement for scientific experts within the OPCW to effectively engage policy makers on technical subject matter.

**Figure 3**: Areas of focus for the OPCW in the implementation of the Chemical Weapons Convention.

**Science and the CWC**

Treaties like the CWC, the NPT and the BWC are underpinned by science and technology. Scientific principles directly inform definitions of classes and categories of weapons; as well as the governing mechanisms and verification of compliance, inspection, and assistance and protection. Science likewise played a key role in treaty negotiation, providing a technical basis on which to build policy. Furthermore, technical experts are necessary to define methods of
disarmament and oversight, and to provide scientific recommendations for technical aspects of cooperative agreements and assistance measures. Despite this basis in science, science and disarmament are often seen to be in opposition. From a security perspective, scientific and technological advancement generates concerns about “dual-use”\(^8\), concerns that can overshadow the consideration of potential benefits. Multidisciplinary scientific development (a common and beneficial practice amongst scientists) has led to concerns of potential challenges to treaty implementation policies which might be based on traditional viewpoints of what does or does not fall under a specific scientific discipline (e.g., the “convergence” of chemistry and biology\(^9\)). Even scientific collaborations, which when focused on peaceful uses of chemistry support the norms of treaty implementation (see Figure 3), generate security concerns due to proliferation of technical knowledge with misuse potential. With scientific and technological developments occurring at a pace that leaves laws, regulations, and treaties lagging behind,\(^10\) there will almost certainly continue to be tensions between science and disarmament related security perspectives.

In the world of chemical weapons disarmament, such tensions (and the potential for distrust of science) are further fueled by recent reports of the use of chemical agents in Syria and Iraq; the commemoration of the first large scale use of chemicals weapons, one-hundred years ago in World War One\(^11\) (under the supervision of chemist and Nobel Laureate Fritz Haber\(^12\)); the legacy of old and abandoned chemical weapons from long gone military programmes;\(^13\) reminders of how the first nerve agents were developed from research on pesticides,\(^14\) and how the first chemotherapy agents were discovered by examining the victims of mustard agent exposure\(^15\) (in this case, perhaps an example of a reverse dual-use discovery).

On the other hand, for a science based treaty that promotes scientific cooperation to build trust between States Parties (“science diplomacy”), scientific development and practices also provide opportunities to adopt new methods for and support the norms of treaty implementation.\(^16\) Given these considerations and science-security tensions, how does a disarmament focused organization effectively use science advice and engage scientists?

To ensure the availability of scientific advice, CWC Article VIII explicitly states that there is a need to “review scientific and technological developments that could affect the operation of this Convention”\(^17\). The OPCW addresses this need through its Scientific Advisory Board (SAB), an independent body of twenty-five scientific experts nominated by States Parties and appointed by the Director-General, to render specialized advice on science and technology (see Figure 4).\(^18\) The SAB meets once to twice a year and has held twenty-two meetings since 1998, the most recent in June 2015.

The technical experts of the SAB are called upon to provide advice to policy makers. Reports of the SAB meetings (the most recent from June 2015\(^20\)) are written in a manner that makes their proceedings accessible and understandable to these policy makers; while at the same time, the considerations and questions addressed by the SAB require researching and compiling substantive scientific information and evaluating scientific conclusions (recent examples include reports on medical treatments for blister and nerve agent exposure,\(^21, 22\) fact-sheets on the toxins ricin\(^23\) and saxitoxin\(^24\), and advice on chemicals that meet the definition of a riot control agent\(^25\)).
The Scientific Advisory Board

“To enable the Director-General, in the performance of his functions, to render specialized advice in areas of science and technology relevant to this Convention, to the Conference, the Executive Council or States Parties.”
- CWC Article VIII, Paragraph 21(h)

Nationalities of the Scientific Advisory Board in 2015

The membership of the Scientific Advisory Board includes experts from 25 States Parties each serving up to two consecutive 3 year terms.

Temporary Working Groups (TWGs) provide recommendations to the SAB on specific issues.

Figure 4: The OPCW Scientific Advisory Board (SAB) in 2015.19

Ultimately, the effectiveness of the SAB lies in its ability to communicate – to take complex scientific information and present it to policy makers clearly enough to inform their policy decisions. Likewise, when policy makers need sound technical advice, they need to ask sound
technical questions of the SAB. To help facilitate this communication, the chairperson of the SAB holds briefings to States Parties, where technical recommendations and findings of the SAB can be explained and discussed.

In effect, the ability to translate scientific and technical conclusions into information that can be used to inform and guide policy is the most critical aspect of providing science advice. Examples of this translation in the context of the CWC can be found in the SABs report on developments of science and technology to a Review Conference of the CWC held in 2013 and the response to this report from the OPCW Director-General.

**Education and Engagement**

Reports from the SAB and documents related to their work are readily available. Reviewing such materials, however, might suggest a highly specialized Board and conversation; with perhaps little accessibility or familiarity to the subject matter for those outside CWC circles (this is really no different from a diplomat reading a paper in a peer-reviewed scientific journal). Such materials, while informative in regard to the scientific issues of relevance to the OPCW, may not be ideal for engaging broader communities of scientists and non-scientists alike. To facilitate awareness raising about chemical disarmament and chemical safety and security issues into broader communities, the OPCW engages in social media and makes a number of publications available through its website, [www.opcw.org](http://www.opcw.org) (see Figure 1). The OPCWs efforts in education and outreach have been further supported through advice and activities from an SAB working group that met from 2012 to 2014.

Just as other international organisations, along with governments and world leaders have embraced social media (especially Twitter) for engaging with the wider world (and one another) – the OPCW maintains a social media presence through which it provide updates on its work, makes available informational (and educational) materials and engages with its stakeholders and the general public. OPCW social media accounts are provided in Figure 1.

To further support awareness raising activities, OPCW produces publications intended to be accessible to broader audiences (Figure 5). Three of these publications may hold interest to those who study and teach chemistry.

The first is a series of Fact Sheets that cover historical, procedural, and some technical aspects of the work of the OPCW (top of Figure 5).

The second, the OPCW Today (bottom of Figure 5) is an in-house periodical with articles contributed by OPCW staff and outside experts. The August 2014 edition is notable as the first issue of OPCW Today to be dedicated to science and technology, containing articles that highlight science in the work of the OPCW and technical papers that include a review of the chemistry of chemical weapon destruction and the chemistry used in the analysis of blood samples to detect exposure to nerve agents.
Figure 5: Examples of OPCW publications: (Top) Fact Sheets\textsuperscript{35}, (Middle) Science and Technology Monitor\textsuperscript{40}, and (Bottom) OPCW Today\textsuperscript{36}. 
The third of these publications is the *OPCW Science and Technology Monitor* (middle of Figure 5), a science focused newsletter. The *Monitor* started as an intern project to report on new scientific developments; it has since become a sort of platform for science communication – providing links and references to technical reports and papers, highlighting descriptive materials accessible to those who may not be subject matter experts, looking at broad and intersecting areas of science and technology, and presenting material in a sometimes humorous fashion to generate interest in science. The *OPCW Science and Technology Monitor* mailing list includes scientists, social scientists, staff members of governmental agencies and ministries, diplomats and policy makers from across the States Parties of the CWC. If one considers that answers to the “S&T Puzzle” feature of the newsletter have been submitted by both scientists and policy makers, the newsletter has informally facilitated scientist-policy maker engagement!

The *OPCW* website hosts other links to resources for students and teachers interested in CWC relevant topics. These include: e-learning modules about the *OPCW* and online training tools for those involved in CWC related activities (specifically declarations and industry inspections); materials from a 2014 conference on education for peace that brought together stakeholders to discuss best practices for raising awareness on disarmament and non-proliferation issues in educational institutions; and, the *Fires Project*, a series of short films exploring personnel stories with chemical weapons related dimensions. *Fires* stories include the ethical dilemma raised by the use of one’s chemistry training to produce weapons (e.g. Fritz Haber) and the story of a man who as a child survived a 1988 mustard agent attack in Halabja.

The *OPCW* supports projects by science educators, a recent example being the IUPAC Multiple Uses of Chemicals Project. The “Multiple Uses of Chemicals” is an interactive online tool that explores the beneficial uses, misuses, and abuses of multi-use chemicals, both historically and presently; the website is designed to be informative for students, educators and policymakers.

Outreach activities of the *OPCW* are further strengthened through public engagement by staff members. Such engagements cover a diversity of audiences and interests across many sectors of society. For those interested in how the *OPCW* raises awareness about chemical disarmament, non-proliferation and the role of science when communicating beyond scientific and diplomatic communities; speeches and statements publicly delivered by the *OPCW* Director-General are available online. Figure 6 is a visualization of the Director-General’s words and provides a high level glimpse at the topics addressed in these public venues.

**Science for Diplomats (and Diplomacy for Scientists)**

The education and engagement resources thus far presented, offer information about the CWC, the *OPCW*, and pertinent issues in the field of chemical disarmament. Effective science and policy maker engagement, however, needs more than reference materials; it requires building trust and forming “partnerships”. When effective, scientists would support policy decisions with analytical thinking and technical insights; while policy makers would provide guidance on where scientific research, inputs, and applications are best suited to help solve global problems.
The first step is learning to communicate. A scientific approach to a problem might start from making an observation then forming a hypothesis, followed by asking questions (running experiments). As those of us trained in science realize, the answer that comes from an experiment often has a bit of uncertainty associated with it, and this is good because it allows us to ask new (and perhaps more interesting) questions. In the world of policy makers, answers to questions are desired (answers that are not themselves question) and uncertainty can bring down political careers! Combine these different approaches to problem solving with the science-security tensions previously mentioned and productive engagement can become difficult.

![Figure 6: The words of the OPCW Director-General. This word cloud, highlighting the common thematic words within the speeches, is the compilation of 22 public speeches delivered from 22 January to 10 October 2015 to audiences that span many sectors of society.]

Policy makers seen by scientists as “science literate” serve to help reduce science-security tensions, this requires good and clear science communication. To help promote science literacy and to compliment other science communication tools, the OPCW initiated a series of “Science for Diplomats” briefings in 2014. These briefings are held as lunch time events during meetings of the States Parties and have covered topics that include: CWC relevant chemical and biomedical analysis, biobased chemical production methods, unintended by-products from chemical processes, medical countermeasures to chemical agents and the technical aspects of the algorithm used to select chemical facilities for CWC inspections. While such briefings are not in-depth science lectures, they serve an important purpose by “de-mystifying” science and creating a link between science and the world of the policy makers. This is especially relevant when considering how to take forward advice and recommendations from the SAB. Additional briefings on science and CWC implementation are provided to meetings of National Authorities of States Parties and new diplomats assigned to CWC delegations. Presentations from the Science for Diplomats and related briefings are available online. This material might lend itself for use as introductory or supplementary information to a chemistry lecture.
Figure 7: A poster illustrating the mechanism of action of organophosphorus nerve agents and some of the types of medical countermeasures used to mitigate these effects.\textsuperscript{61} This poster is one of a number of technical graphics available from the Science and Technology section of the OPCW website.\textsuperscript{62}

From a policy maker’s viewpoint and in light of science-security tensions, scientists who are seen as aware of the potential for misuse of science and who promote responsible practices to prevent such misuse can help to build trust. In this regard, the topic of codes of conduct and
ethics for scientists as a way to promote responsible science is often raised. In support of ethical practices in chemistry relevant to the CWC, a group of chemistry practitioners recently drafted “The Hague Ethical Guidelines”, a set of elements that provide CWC relevant inputs to complement the many already existing codes from chemistry relevant organisations.

**Science for scientists**

For those interested in more in-depth scientific and technical aspects of the work of the OPCW, the Science and Technology section of [www.opcw.org](http://www.opcw.org) hosts science resources in the form of presentations and posters. Figure 7, a poster explaining the mechanism of action of organophosphorus nerve agents and medical countermeasures against them, is one example; a collection of similar graphics is available online and new documents are regularly added to the site.

**Concluding Thoughts**

There is a clear need to engage those with scientific and technical expertise to address issues of global importance. As forward looking and robust policies in any sector rely on sound technical inputs, it is valuable to explore ways to inform students about the intersection of science with world events and decision makers. While many examples can be found to meet these needs, disarmament treaties, in particular the CWC, can provide examples from chemistry to help make such connections. In this regard, Figure 1 is an interactive map to a variety of resources from the OPCW that may provide opportunities to discuss disarmament issues with chemistry dimensions.

Spring 2016 presents another opportunity to discuss the CWC, the OPCW and the role of chemistry in global events. The OPCW, the IUPAC Committee on Chemistry Education (CCE) and the ACS CHED Committee on Computers in Chemical Education (CCCE) are offering a Spring 2016 ConfChem online conference on “Chemistry, Disarmament and Education”, to start on 6 May 2016. Papers will highlight examples from the CWC in the teaching of chemistry; describe the analytical chemistry of chemical weapons inspection and how it is used for decision making; examine definitions of toxicity; explore the chemistry of riot control agents; consider how simple sensors can be used to teach concepts in analytical chemistry and facilitate international collaborations; and discuss responsible science and ethical considerations in chemistry. This is an open access virtual colloquium and all are welcome. Further information is available from the ConfChem homepage.

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References

1. While not an OPCW resource, those interested in science advice to policy makers and governments can obtain useful information and resources from the International Network for Government Science Advice; http://wwwglobalscienceadvice.org/.


5. Annual reports of OPCW activities available at: https://www.opcw.org/documents-reports/annual-reports/.


7. In this regard, OPCW offers a number of capacity building programmes for science in developing countries; more information is available at: https://www.opcw.org/our-work/international-cooperation/capacity-building-programmes/.

8. “Dual-use” describes science and technology developed or used for civilian purposes that has the potential for military application or can contribute to the proliferation of weapons of mass destruction.


18. Additional information about the OPCW SAB is available at: [https://www.opcw.org/about-opcw/subsidiary-bodies/scientific-advisory-board/](https://www.opcw.org/about-opcw/subsidiary-bodies/scientific-advisory-board/).


26. The most recent Briefing by the SAB Chair, from 7 October 2015 is available at: [https://www.opcw.org/fileadmin/OPCW/SAB/en/TIMPERLEY_EC-80_Briefing_States_7_October_2015_FINAL.pdf](https://www.opcw.org/fileadmin/OPCW/SAB/en/TIMPERLEY_EC-80_Briefing_States_7_October_2015_FINAL.pdf).


33. “How do International Organisations Tweet in 2015?”, http://twiplomacy.com/blog/how-do-international-organisations-tweet-2015/. Mentioned in this article is the communication on Twitter from the Nobel Prize Committee on 11 October 2013 – the announcement that OPCW had been awarded the Nobel Peace Prize.


35. Available at: https://www.opcw.org/documents-reports/fact-sheets/.

36. Available at: https://www.opcw.org/documents-reports/opcw-today/.


40. Current and past issues of the *OPCW Science and Technology Monitor* are available at: https://www.opcw.org/special-sections/science-technology/science-technology-monitor/. To be added to the mailing list, sign up at the link above or email SciTech@opcw.org.

41. See https://www.opcw.org/special-sections/education/.

42. Information on how to get access to OPCW e-learning tools can be found at: https://www.opcw.org/special-sections/education/e-learning/.


45. Fires: A Teachers Mission; https://www.opcw.org/special-sections/education/fires/. The link includes materials for a classroom lesson related to Fritz Haber and the ethics of applying the knowledge of chemistry to warfare.


50. “Chemical Analysis in the Verification of the Chemical Weapons Convention”, Science for Diplomats 9 July 2014, 

51. “Conducting Analysis of Biomedical Samples to Assess Exposure to Organophosphorus Nerve Agents”, 

52. “The Science of the Bioeconomy”, Science for Diplomats, 5 December 2014, 

53. “Schedule 1 and 2 chemicals as captive intermediates and unintended by-products”, Science for Diplomats, 

54. “The Science of Medical Countermeasures”, Science for Diplomats, 8 July 2015, 

55. “Data Analytics and the CWC: An Introduction to OCPF Site Selection Methodology”, Science for Diplomats, 

15th Workshop for Diplomatic Personnel Involved in the Work of the OPCW, 30 September 2015, 


58. For example: https://www.opcw.org/special-sections/science-technology/the-hague-ethical-guidelines/background-information/.


60. An analysis of existing codes performed as a part of the workshop that drafted The Hague Ethical Guidelines, identified 142 existing codes of conduct and ethics relevant to chemistry – the list included only English language documents and was by no means comprehensive. More information can be found in the workshop report (the compiled set of codes are available on request, email SciTech@opcw.org). https://www.opcw.org/fileadmin/OPCW/SAB/en/Hague_Ethical_Guidelines_2nd_Workshop_Report.pdf.

