Editorial Introduction: Ethical Case Studies of Chemistry

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Perhaps more so than ever, chemical know-how is in demand for providing solutions to many global issues, including the protection of the natural environment, healthcare, nutrition for a growing world population, water treatment, energy production, waste treatment, and the development of recyclable resources. Rather than just doing chemistry in the lab, chemists are required to engage with other disciplines and with society at large to work together on managing these issues. Of course, real life solutions are never as simple as those for crossword puzzles. They always involve various advantages and disadvantages, improvements and drawbacks, opportunities and risks, to be discussed and balanced against each other. Thereby chemists are inevitably involved in disputes about values. They would badly fail if they were not prepared to reflect on the values, develop and analyze moral and political arguments, build moral judgments and perform responsible actions, all of which belong to the domain of ethics.

Within the last decade Responsible Research and Innovation (RRI) has appeared on the European Research Agenda, it is now promoted throughout the Horizon 2020 objectives. Chemists and chemical engineers working in academia are expected to be familiar with the ethics of research, technology, and innovation, and are expected to behave responsibly. Chemists and chemical engineers working in the private sector face similar expectations. The Corporate Social Responsibility (CSR) agenda requires corporations to act responsibly and to take part in solving societal challenges. Chemists and chemical engineers should engage in RRI and CSR activities in collaboration with other scholars and professionals. Familiarity with ethical case studies that link chemistry to societal issues is a requirement for any such engagement.

For many years national and international organizations, such as UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), have therefore recommended mandatory courses of ethics for all university students of science and engineering. While such courses have been established in numerous countries and for various student groups, chemistry is still lagging behind, despite the particular importance to

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the discipline. One reason for that is the one-sided focus on epistemological and ontological issues by many philosophers of chemistry.

Another reason is the lack of appropriate course material that assists both philosophers and chemists to teach such courses. This special issue on 'Ethical Case Studies of Chemistry' has been edited for the purpose of filling that gap. It encourages ethics of chemistry courses based on a canonical set of case studies to be enriched by more papers in the future. We hereby issue an ongoing Call for Papers to develop the set further.

Hopefully this collection will help educate a future generation of chemists that are more aware of ethical issues than former generations, who tend to think of chemistry as a value-free endeavor. More ambitiously we envision a future generation of chemists who are able to

- learn from pertinent historical cases of chemistry that have been in the focus of public disputes on how to avoid mistakes;
- conduct ethically responsible research;
- develop their own balanced ethical position that they are able to defend with ethical arguments and communicate to colleagues and the public at large;
- avoid being misled by corporate or governmental interests towards unethical behavior;
- help improve the public image of chemistry that revealingly contains elements of social isolation, lack of circumspection, and unscrupulous behavior.

The scope of ethics of chemistry is broader than many would think. It includes every value aspect of chemical activity, from basic knowledge building and teaching to research, development, and applications in academic, industrial, or governmental settings. For each activity we can ask questions such as: What values, norms, and obligations do chemists follow? What do they intend to achieve? What are the broader consequences of their activities? Are the foreseeable positive and negative outcomes, including possible risks, well balanced? Do they make all efforts to estimate the possible outcomes based on the best available knowledge? Are they responsible and to be blamed for the adverse effects of their actions, even if they did not intend to cause them? Are the norms of both individual chemists and the chemical community in accordance with general ethical standards? Does their research provoke conflicts with established cultural values? *Etc.*

In our call for papers to this special issue of *HYLE* we solicited ethical analyses of cases that bear one or more of the following characteristics:

1. *Intentional misuse and misconduct*, *e.g.*, scientific misconduct in chemistry, chemical weapons research, support of drug abuse.

2. *Unforeseen consequences*, *e.g.*, industrial pollutants, industrial disasters, adverse side-effects of products.
3. *Global and long-term influences and challenges*, *e.g.* chemical predictions of environmental or health problems, geochemical engineering, green chemistry, global human and environmental challenges for chemistry, impact on global economy.
4. *Impact on human culture*. How do chemical agendas affect cultural values, ethical principles, or religious ideas? Possible cases include patenting DNA, creation of life, human enhancement, and chemical modernism.

The following papers, which together form the first part of this special issue and which will be complemented by a second part in 2017, are structured according to these four topics.

Hence, we start with a fictitious case of scientific misconduct that we invited Janet D. Stemwedel to write for this occasion. In her case study we meet a Ph.D. student who cannot reproduce the experimental data published by a recognized former member of the research group. As the case develops the reader gradually realizes that fabrication has been involved. The fictive case is analyzed with the help of Muriel J. Bebeau's strategy for ethical decision-making. As the analysis progresses, various dilemmas faced by a number of involved people unfold, illustrating the ethical complexities of typical real cases of scientific misconduct.

The second paper asks if the research, development, and production of chemical weapons can be characterized *per se* as misuse of science. Stephen M. Contakes and Taylor Jashinsky use the two examples of Louis Fieser, the inventor of Napalm during the Second World War, and Dow Chemical, one of the producers of Napalm during the Vietnam War. Based on Just War theories, their analysis is focused on the issue of whether the actors knew about and supported the actual military mass deployments of Napalm against civilians, which by all standards count as severe war crimes. While they find Fieser, as WW II developed, increasingly guilty, they see Dow at least struggling with ethical issues and betrayed both by US politicians and the military through misleading information.

The next three papers deal with different aspects of unforeseen consequences of industrial chemicals. Klaus Ruthenberg investigates the early phases of the Thalidomide scandal in Germany that resulted in the births of thousands of malformed newborns and stillborn babies over several years. In the late 1950s the company Grünenthal praised Thalidomide (Contagan) as a 'wonder drug' that enables a good night's sleep without any side effects. The results were based on questionable scientific practice. Early warnings were dismissed for economic reasons. In his ethical analysis the author discusses how the most important players in the case complied with four ethical principles: respect for autonomy, non-maleficence, beneficence, and the principle of justice.

In their contribution Alistair Iles, Abigail Martin, and Christine Rosen examine the debate on potential public health risks of Bisphenol-A (BPA). The industrial chemical, of which thousands of tons have been produced annually for a number of decades, may cause harm due to its endocrine disruptive effects, according to some experts but not according to all. Also newly developed substitutes for BPA might have similar unknown adverse effects. The paper critically discusses standard risk assessment procedures and industrial chemicals regulation in the USA. In their ethical analysis of how to deal with such uncertainties the authors point out prototypical positions of key actor groups – managers/corporations, chemists/designers, and regulators/legislators – by distinguishing between deontology, consequentialism, and technocracy.

Ragnar Fjelland presents a case study where lay people were right and experts were wrong about the health effects of living in a suburban town called Love Canal that was built on top of a former chemical waste disposal site. The official experts used scientific models and statistical methods with underpinning assumptions that did not capture the distribution of health problems among the citizens. The citizens themselves joined forces with other scientists to develop a model that incorporated their local knowledge. The author argues that scientists can fruitfully involve and collaborate with citizens, and should do so if they adopt the Precautionary Principle. They must not over-sell their conclusions and should inform the public about uncertainties.

The final two papers address cultural and societal aspects of chemistry. Based on a three-step model for making ethical judgments, Klavs Birkholm discusses psychotropic drugs as chemical tools for human enhancement. First one should recognize the risks posed by a chemical drug to individuals, then assess the possibility for misuse, and finally imagine the cultural consequences of widespread drug use. The author identifies three potential cultural/societal consequences of psychotropic drugs: a medicalized culture that suppresses individuality, the fading quest for social recognition as an important driver of societal developments, and chemical enhancement becoming a societal norm that undervalues natural qualities.

In the final paper Joachim Schummer investigates societal and ethical issues of creating artificial life, from pre-modern times up to current Synthetic Biology. His case in focus is Craig Venter's 2010 announcement of having produced the first self-replicating cell, echoed by a worldwide media accusation of Venter 'playing God', which chemists in various forms have faced ever since. While the scrutiny of ethical arguments behind that accusation reveals meager results, the author argues that Venter himself provoked the public reaction in order to attract media attention. Which raises the question of how to responsibly interact with the public on ethical issues.

The seven papers of this issue form only a starting point for developing a canonical set of case studies that are useful for teaching ethics to chemistry students. The forthcoming issue of *HYLE* will include cases on DDT, the Bhopal disaster, Green Chemistry, and the European chemicals regulation REACH, some of which will deal with global and long-term effects of chemistry. Further cases will follow on an irregular basis.

Chemists might wonder why our collection focusses on 'negative' cases, where chemists violated ethical norms, and if that would not draw an overly negative image of chemistry. To that widespread concern we may give three answers: First, negative cases have the didactical advantage of raising awareness within a community that traditionally considered ethics education of little or no importance. Second, the more useful cases are actually those that are not so easy to decide on, because they require different values to be balanced against each other or because they describe actors in an ethical dilemma. In fact, most of our cases are of that type. Third, we are very open to 'positive' cases, where individual chemists or chemical organizations act as role models and make ethical values their main guideline of research, like in Green Chemistry. Perhaps the most prominent case is that of Mario Molina and Sherwood Rowland, who first discovered stratospheric ozone depletion by chlorofluorocarbons (CFCs) and then actively engaged in politics to reach an international ban on CFCs (Montreal Protocol).

Further Reading

University teachers who are, or would like to get, involved in teaching ethics to students of chemistry and chemical engineering, may find further information in the following list of resources. Some, but not all, of the resources are focused on research ethics, *i.e.* on the responsibility of scientists to other scientists for avoiding scientific misconduct such as plagiarism. That is to be distinguished from general ethics of science, *i.e.* the moral responsibility of scientists to society.

Books

Beach, D.: 1996, *The Responsible Conduct of Research*, Weinheim: Wiley-VCH.

Kovac, J.: 2003, *The Ethical Chemist: Professionalism and Ethics in Science*, Upper Saddle River, NJ: Pearson Prentice Hall.

Resnik, D.B.: 2012, *Environmental Health Ethics*, Cambridge: Cambridge University Press.

Whitbeck, C.: 1998, *Ethics of Engineering Practice and Research*, Cambridge: Cambridge University Press.

Wildavsky, A.: 1995, *But is it True? A citizen's guide to environmental health and safety issues*, Cambridge: Harvard University Press.

Paper Collections

Ethics of Chemistry (2001/2002), ed. by Joachim Schummer, special issue of *HYLE: International Journal for Philosophy of Chemistry* (vol. 7, no. 2; vol. 8, no. 1) (http://www.hyle.org/journal/issues/7/hyle7_2.htm, http://www.hyle.org/journal/issues/8-1/index.html).

European Perspectives on Teaching Social Responsibility in Science and Engineering, (2013) ed. by Henk Zandvoort, Tom Børsen, Michael Deneke & Stephanie Bird, special issue of *Science and Engineering Ethics* (http://link.springer.com/journal/11948/19/4/page/1).

Ethics and Responsible Conduct of Research within the Chemical Community (2015), ed. by Jeffrey I. Seeman, special issue of *Accountability in Research* (http://www.tandfonline.com/toc/gacr20/22/6).

Science, Disarmament, and Diplomacy in Chemical Education: The Example of the Organisation for the Prohibition of Chemical Weapons (2016), collection of papers by the Organisation for the Prohibition of Chemical Weapons (OPCW) (http://confchem.ccce.divched.org/2016SpringConfChem).

Case Studies

Online Ethics Center for Engineering and Science: *Resources/ Case Studies* (http://www.onlineethics.org/).

Center for the Study of Ethics in the Professions at Illinois Institute of Technology: *Ethics Education Library/ Case Study Collection* (http://ethics.iit.edu/eelibrary/).

American Chemical Society: *Materials for Ethics Education* (case studies on research ethics) (https://www.acs.org/content/acs/en/about/governance/committees/ethics/ethics-case-studies.html).

European Environment Agency: *Late lessons from early warnings: the precautionary principle 1896-2000*, Copenhagen, 2002 (http://www.eea.europa.eu/publications/environmental_issue_report_2001_22).

European Environment Agency: *Late lessons from early warnings: science, precaution, innovation*, Copenhagen, 2013 (http://www.eea.europa.eu/publications/late-lessons-2).

Professional Codes of Conduct

Center for the Study of Ethics in the Professions at Illinois Institute of Technology: *Ethics Codes Collection* (http://ethics.iit.edu/ecodes/search/site/chemistry).

International Council for Science: Overview of national and international codes of conduct (http://www.icsu.org/freedom-responsibility/research-integrity/statements-codes-reports).

Evers, K.: 2001, 'Standards for Ethics and Responsibility in Science: An analysis and evaluation of their content, background and function, International Council for Science: Standing Committee on Responsibility and Ethics in Science (SCRES), (http://www.icsu.org/publications/reports-and-reviews/standards-responsibility-science/SCRES-Background.pdf).

Further Organizations & Initiatives

UNESCO, Program on Ethics of Science and Technology (http://en.unesco.org/themes/ethics-science-and-technology).

The Hague Ethical Guidelines (2015): *Applying the norms of the practice of chemistry to support the Chemical Weapons Convention* (https://www.opcw.org/special-sections/science-technology/the-hague-ethical-guidelines/).
International Organization for Chemical Sciences in Development (IOCD, since 1981) (http://www.iocd.org).
One-World Chemistry (since 2016): *Systems thinking to shape the chemical sciences for sustainable developmen*t: Chemistry must go beyond 'being a science' and embrace 'being a science for the benefit of society' (http://www.oneworldchemistry.org).
RRI-Tools: *Tools to support Responsible Research and Innovation in the European Union directed towards different target groups including university teachers* (http://www.rri-tools.eu/).

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