Francesco Dondi
Dipartimento di Chimica
Università di Ferrara
f.dondi@unife.it

WHY AND HOW TO TEACH ETHICS IN CHEMICAL EDUCATION

Ethical concepts are necessary for chemist for contributing to build up a Culture of Responsibility and the establishment of course of ethics for chemist curricula is an important complement of its education.

A growing demand of ethics is coming today from several sectors of the society: it is becoming in fact clearer that intentional and non intentional irresponsibility has been the cause of many of the present emergences and disasters e.g. in environmental or financing context. For instance, in the case of a natural disaster like the Abruzzo earthquake, it is evident that it was not the absence of rules but the uncorrect application of them that made the consequences most ruinous. Educational System is thus asked to take pertinent initiatives.

Italian Chemical Society, since several years, considers ethics a strategic aspect of its institution commitment [1]: a Charter of Ethical principles has been established. High School and University curricula should now include this as an essential part of the modern education of a Chemist. In addition, Educational system should contribute to a develop the a "Culture" of "Responsibility" [2].

The "Culture" of Responsibility is in fact that condition in which not only the individuals but also the society as a whole behave with responsibility and takes concrete initiatives to face the present and the forthcoming problems. But this needs a pertinent knowledge of the problems and capability to afford them. "Responsibility" means, in fact, capability to "respond", i.e. the capability to both detect the specific needs the present time is urging us and to give them pertinent answers. "Responsibility" connects in a complementary way thinking to *action*. "Responsibility" - Benedetto Croce [3] synthetically says - "raises for practical purposes and it is a moment of the dialectic of doing": Chemistry, in its specificity as a science, has an extraordinary

Presented at AT3P (IFP-School, Paris), MASPENS (University of Roma) & MaSTeM (University of Ferrara): Three master classes meet together at the "Giulio Natta" Research Centre/LyondellBasell. Ferrara, April 3rd 2009

capability of giving pertinent answers, and we, as Chemists, have unique opportunities to contribute to the establishment of this "Culture of Responsibility".
It is thus evident that not only "Chemistry" as a pure science must be delivered in modern chemistry curricula, but also that specific attitude the Chemists must have in understanding current problems and giving them the appropriate answers: ethics should thus be an essential frame of reference for chemist.
In this study, reference to environmental problems will be made. This is only one part of the problems of ethics in Chemistry, which cannot obviously be exhausted by the present approach.

How and what to teach? A renewed approach in education

If the "why " to teach ethics in Chemistry curricula seems firmly motivated, how and what to teach is an open field. In this paper we will give a contribution coming from our recent experience developed with the concourse of several colleagues and eminent scientists. In several Italian University Faculties, especially Engineering, see Fig. 1, Courses of ethics are already delivered.
A Course in ethics must convey not only knowledge but culture. In this sense we have to contribute to define what it is "a well behaved mind", instead of a "full mind" [4]. The Course of ethics should be an occasion for accompanying students and, with them, teacher, to achieve the challenging results of a renewed education within an evenly renewed vision of the major questions of the world: environment, food, water resources, climate changes, wastes etc..
The need for general renovation in Education was established in authoritative way by UNESCO, who committed to Edgar Morin - famous French Sociologist - a study [5] resulted in the seven following guidelines necessary for the present century:

1. Detecting error and illusion
2. Principles of pertinent knowledge
3. Teaching the human conditions
4. Earth identity
5. Confronting uncertainties
6. Understanding each other
7. ethics for the human genre

In this paper we will try to translate in a language understandable to chemists some of the above reported points.
To start up this renewed ethical approach, it is necessary to recall students some basic concepts derived from the philosophical western tradition (e.g. Aristotle, [6, 7], and H. Bergson [8]). In addition - to make the topic actual - at least two basic key references of the recent philosophical and sociological debate should be referred: they are the "Imperative of Responsibility" by of Hans Jonas [9] and "The Risk Society" by of Ulrich Beck [10] respectively. In fact, ethical impact of chemist's action affects both mother nature and society, and these two basic essays speech a language that can be fruitfully heard by a chemist.
We believe that making reference to strong ideas since the beginning of a Curse of ethics, has the advantage to show students the wide horizons - spatial and temporal- in which mankind and thus their own life is inserted [2, 11].

Premises: classical and renewed philosophical and sociological concepts

One must first recall the meaning of the word "ethics": it comes from Greek $\eta\theta o\zeta$, i.e. character, behavior, habit. It is a major branch of philosophy, encompassing right conduct and good life. Its meaning is significantly broader than the common conception of analyzing *right and wrong* [12]. In fact, a central aspect of ethics that it is often neglected is that ethics concerns "the good life", i.e. *happiness*. This last concept is most important in establishing the role of ethics and science for the environment [13]. A sustainable development which consists in reaching good conditions of life for everybody now and for the future is, in fact, true happiness. Thus, if something or someone is *unhappy*, and this comes directly or indirectly from our activity as chemists, this is also *unethical* and calls for a pertinent response. The relevance of this positive aspect of ethics and the role of the science and thus of the chemistry towards the Society should be emphasized.
Aristotle (Nicomachean ethics (NE), [6]) well underlines this central aspect of ethics through this famous sentence: *ethics (Politics) is… the most authoritative and architectonic science.*
The architectonical character of ethics represents an intrinsic feature of ethics (see Note at [6]). The role of ethics in building up our towns in the broadest sense is thus here established. Consequently ethics concerns features and rules for our habitat and chemistry is deeply concerned. Moreover according to Aristotle, the town - and thus our

Fig. 1 - Ethics Courses in Italian Faculties (adapted from [2])

habitat - is not an ideal concept but it is the place where real life is played [7].

The need for humans to build up ethics comes, according to the French philosopher H. Bergson [7], from two antagonistic feelings: the *Fear* and the *Hope*, being them at the basis of moral obligation and creative emotion [7c], respectively, the two driving forces of morality and religion.

Fear is a sentiment affecting us in front of dangers and in general the unknown, i.e. the risk. This is the case of unwanted effects of the technological progress determined by the combined action of science, technique and economy. This is widely described in the current literature and we recall here as examples the Introduction of Jonas' book with the Prometheus figure [8c]: *"Prometheus, unleashed definitively, to whom science gives unprecedented strengths and economy an untiring impetus, calls for ethics that through voluntary restraints will restrain its power to harm humanity"* [8d]; or the figure of Angelus Novus in a famous page of W. Benjamin [14]: *"There is a painting by Klee called Angelus Novus... But a storm is blowing from Paradise and has got caught in his wings... This storm drives him irresistibly into the future to which his back is turned, while the pile of debris before him grows toward the sky. What we call progress is this storm".*

L'Angelus Novus di Paul Klee

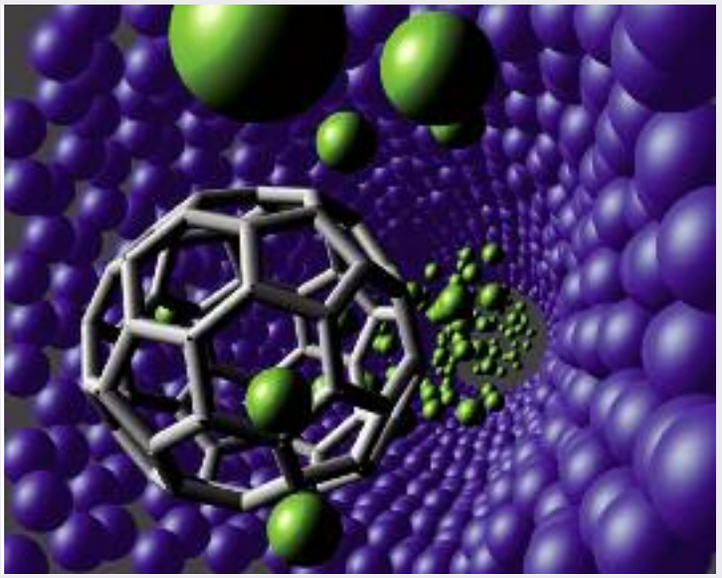
This was the description of the character and issues of the so called "technoscience", i.e. the negative effects of the cooperative actions of science-industry and economy ([2] chaps. 7 and 8) which, in the context of the Nazi period, was so evident to W. Benjamin.

Starting from the Sixties of last century, the negative effects over the environment produced by the "technoscience" became a common feeling ([2], chap. 9), and in this regards, chemical activity was deeply involved. Significant was the number of scientists and philosophers who contributed to the understanding of these problems ([2], chapts 7-9). These must be considered as modern "prophets". To mention only few of them: Rachel Carlson, Aldo Leopold. Students in all scientific and technological curricula should be acquainted of their role in the recent history of environmental sciences, and must participate to the debate on the world status (e.g. for a synthetic presentation [2], chaps. 1-5). A dichotomy in the student mind - school on one part and society problems in another part - should be avoided. Students, should know important crucial questions concerning chemistry currently handled e.g. in *La Chimica e l'Industria,* or important contributions of chemists concerning the present time: we only remember Richard R. Ernst [15] and Vincenzo Balzani [11]; Hans Jonas, with his famous essay *"The Imperative of Responsibility. In Search of an ethics for the Technological Age*" published in Germany in 1979 [9] played a most relevant role in updating ethical concepts in philosophy as a consequence of environmental impact of technique. This important essay was published 1979 but it was translated only on the Nineties in Italy [9a, c]: this says something about the delay in Italy with respect to the international discussions about ethics and science.

The key concept of Jonas' "The principle of responsibility" [9] can be shortly condensed in: *"Act so that the effects of your action are compatible with the permanence of genuine human life"*.

The need of a renewed principle of responsibility is dictated by the specificity of the impact of modern technology upon Nature. Our actions have now the multiplicative and cooperative effects coming by interaction of science, industry and economy (see above the reported reference to Prometheus and [2], chapts. 7-9). The condition of "proximity" and "contemporaneity" (*hic et nunc*) which was a background for ethics in the pre-modernity (see at the beginning of [9] the comment to Antigone's Chorus), does not exist anymore as unique criterion for judging the present modern technical praxis. The sphere of human action is in fact no more restricted to the "house" or "city" ambits: the whole biosphere is involved. Not only the present is affected, but the effects of mankind activity deeply project itself in the future and can even compromise the itself persistence of life on the earth. Pertinent examples for students are: 1) bioaccumulation of pollutants and their spreading over the world because of the atmospheric transport processes; 2) enhancement of greenhouse effect; 3) changing energy paradigms; 4) problem of water resources etc. (see [2], chapts 1-5). By using the concept of definite integral as a sum of vanishing small contributions, the effect of emerging problems (e.g. emerging contaminants) can be easily explained as a sum of many single van-

ishing small effects. The concept of thermodynamic irreversibility can explain an irreversible risk and thus the difference existing between damage and crime. In all these aspects we can make pertinent use of the classical chemical disciplines as physical chemistry, analytical chemistry, and so on. Students should also know that most of the regulatory action developed at European level is embedded of ethical concepts: to recognize them will be important in their future activities. One example is the so called "Proximity Principle", involved in regulations concerning wastes (waste for disposal should be dealt with as close as possible to its generation), another is the most general "Precautionary Principle" [16].



Beside that of H. Jones, the second relevant contribution (1986) went from the field of Sociology. It was the famous definition of the concept of "*Risk Society*" put by Ulrich Beck at the beginning of its essay [10]: *"In advanced modernity the social production of wealth is systematically accompanied by the social production of risks*".

This is the so called "second modernity" where the perception of risk is bringing common people to a kind of refusal of modernity. We again recognize in this aspect the component of "*Fear*" above mentioned. We can remember now how fear shows itself in the strong refusal, in Italy, of incinerators, in the request of "biological foods", in the search of new life stiles, in the refusal of science itself… One can understand thus that the Risk Society is an unhappy society and thus a non ethical one, according to the basic principles above recalled.

To understand the roots of modernity refusal, it is useful to remember the history of the most relevant environmental disasters, like Seveso, Bhopal or Chernobyl and their impact over society. The dimension of "memory" is in general neglected in science and it must be recovered (see [2], p. 170, with reference to the philosopher of science T. Kuhn). Chemists, since the beginning of their education, should develop, as recommended by R.E. Ernst, the sentiment of compassion [15a, b], which is a *virtue* of intellect: "Compassion comprises the emotional aspects, such as love and pity; Wisdom has much to do with a broad view, with the comprehension of connectivity, Knowledge is indispensable for reaching wisdom and for exerting compassion, but it is operative on a different, more supportive level" [15a].

The description by *Der Spiegel* (50, 1984, p. 180) of the Bhopal disaster reported in [10a], page 43 (or [10b], p. 57) can be particularly effective:

"The birds fell from the skies…
Water buffaloes, cows, dogs lay dead in the streets and in the fields...
and everywhere the asphyxiated people…
there were 3,000 of them by the end of last week...
20,000 people will probably go blind...
an industrial apocalypse without parallel in history occurred".

It can be observed that many industrial disasters with their tremendous impact like Bhopal, Seveso, Chernobyl were unexpected and often unforeseen.

In the context of "Risk Society", the impact of technologies upon Nature is not the most relevant aspect. The most important problems are the "handling" and "governance" of technologies. Emerging problems are expressed now in terms of administrating, recognizing, hiding technologies and facing the "unexpected". Once the "unexpected" arrived, one can be capable of making revision of both ideas and theories as an essential part of knowledge and thus of the education.

New commitments for science

As a general consequence of this deep and wide impact of human activity, politics is unavoidably forced to recognize in knowledge a fundamental tool for making decisions and thus to assign to science a specific role in decisional and governance processes. For example, now it is the law that finally dictates to science (and not vice versa, see [2], ch. 9) what it is requested or it is allowed by "Precautionary Principle" for the management of new and emerging risks [16]. In this complex process, science is helping law to define the unwanted risks and the possible alternatives. However, these questions call again science. For example, chemometrics with the pertinent concepts of errors and the probabilistic approach in error detection can be particularly helpful. Consequently if, on one hand, second modernity seems to refuse science, in the other science returns as the only tool to focus the details of an acceptable condition of life. All this matter underlines an essential and new commitment for chemists towards the society and calls politics to change attitude towards science. This opens the question of the specific roles of science and politics which will be handled in a subsequent study.

What above referred explains, with specific examples, the need for new guidelines in education as suggested by E. Morin. In particular we can recognize the relevance of the above mentioned guideline: detecting errors and illusion ([5a], p. 11, and [5b], p. 31). In fact, as E. Morin says: "The unexpected surprises us. Because we are too safely ensconced in our theories and ideas, and they are not structured to receive novelty". "So many sources, so many causes of error and illusion endlessy renewed in all our learning! This is why, in all stages of education, we must bring out major questions on the possibility of true knowledge".

Conclusions

In this short report we have tried to show how ethical concepts are necessary for chemist for contributing to build up a "culture of responsibility", the sole capable to face the immense and complex problems hanging over us.

It was remembered that there is a strict link between science and politics, but this relationship needs to be discussed and defined. The point will be faced, together with a more detailed description of the content of a Course on ethics and science for the Environment, in a second part of this study. To conclude we observe that it is becoming increasingly more necessary to join the scientific and humanistic cultures, stayed for a too long time proudly alone and we, as scientists, we must play our part in this venture.

Acknowledgments: Alberto Cavazzini, Simone Mori and Luisa Pasti are gratefully acknowledged for the useful discussions.

References

[1] www.soc.chim.it/it/documenti/carta_dei_principi.

[2] P. Pozzati, F. Palmeri, Verso la cultura della responsabilità. Ambiente, tecnica, etica, Ed. Ambiente, Roma, 2007,

[3] B. Croce, Etica e Politica, Adelphi, Milano, 1944, 948 (cit. [2], p. 254).

[4] E. Morin, La mente ben fatta, Ed. Cortina (La tête bien faite, Seuil, Paris, 1999)

[5] a) E. Morin "Seven Complex Lessons in Education for the Future", UNESCO Publishing, Education on the Move, available at http://unesdoc.unesco.org/images/0011/001177/117740eo.pdf; b) "I sette saperi necessari all'educazione del futuro", Raffaello Cortina Ed., Milano, 2001.

[6] Aristotle, The Nicomachean ethics, (EN). Note: There are many available English translation, e.g. Penguin Books, London 1955. However for the here reported citations we followed the suggestions kindly given us by Arianna Fermani, who prepared the Italian translation (Bompiani, Aristotele. Le Tre Etiche, with the Greek text). In particular the term "architectonic" here employed at EN, I, 2, (1094b), is the correct translation of the original Greek text. This significant adjective is expressed in various ways in several English translations, but the original strong meaning is often lost.

[7] G. Reale, Introduzione a Aristotele, Ed. Einaudi, Torino, 1974.

[8] a) H. Bergson, "The two sources of Morality and Religion", University of Notre Dame Press; b) Le due sorgenti della morale e della religione, SE ed. 2006, Milano; c) http://plato.stanford.edu/entries/bergson/#6.

[9] a) H. Jonas, Das Prinzip Verantwortung. Versuch einer Ethik für die Technologische Zivilisation, Insel Verlag, Frankfurt am Main, 1979; b) H. Jonas, "The Imperative of Responsibility", The University of Chicago Press, Chicago, 1984; c) H. Jonas, Il Principio responsabilità. Un'etica per la civiltà tecnologica, Einaudi, Torino, 1990); d) Translation of the Author's preface reported in 8c, p XXVII found in: www.sommets-tourisme.org/e/sommetsG/premier-sommet/actes/rubitschon.html

[10] a) U. Beck, "The Risk Society, Towards a New Modernity", Sage Publication, London 1992 (original German publication, 1986); b) "La Società del Rischio. Verso una seconda modernità", Ed. Carocci, Roma, 2000.

[11] N. Armaroli, V. Balzani, Energia per L'astronave Terra, Zanichelli, Bologna, 2008.

[12] http://it.wikipedia.org/wiki/Etica

[13] J. DesJardin, Environmental ethics, An Introduction to Environmental Philosophy, 4th Ed. Thomposn, Wadsworth, Belmonth, CA, 2006.

[14] a) Walter Benjamin, "Theses on the Concept of History",1940; b) W. Benjamin, Angelus novus, Tesi di filosofia della storia, Einaudi, 1962, pp. 76-77, http://en.wikipedia.org/wiki/Angelus_Novus.

[15] R.R. Ernst, *Chimica e Industria,* 2007, **89**(7), 154; b) *ibid.,* 2007, **89**(9), 116.

[16] a) http://unesdoc.unesco.org/images/0013/001395/139578e.pdf; b) The Precautionary Principle is defined as follows: "When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm. Morally unacceptable harm refers to harm to humans or the environment that is: threatening to human life or health, or serious and effectively irreversible, or inequitable to present or future generations, or imposed without adequate consideration of the human rights of those affected". http://www.precautionaryprinciple.eu/.