



Teaching Ethics

to Science and Engineering Students



Report from a follow-up symposium to the 1999 World
Conference on Science. Copenhagen, April 15–16, 2005.

Teaching Ethics to Science and Engineering Students¹

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Abstract

In April, 2005, the Center for the Philosophy of Nature and Science Studies hosted a symposium focusing on the World Conference on Science recommendation: That the ethics of science should be an integral part of the training of scientists and engineers. In this paper one of the main conclusions of the symposium is presented and discussed: If the teaching of ethics to science and engineering students is seen as part of a strategy for securing sustainable development and betterment of the human condition, then the basic ethical principles and responsibilities of science, which the students are required to internalise must refer to something more than the main types of ethical theories (i.e. consequentialism, utilitarianism, virtue ethics, deontological theories and contractualism).

Introduction

April 15 and 16, 2005, Center for Philosophy of Nature and Science Studies at the University of Copenhagen, in association with the Danish UNESCO Committee, Centre for Ethics and Law in Nature and Society, and International Network of Engineers and Scientists for Global Responsibility (INES), organised a follow-up symposium in Copenhagen to the UNESCO and International Council of Science (ICSU) World Conference on Science (WCS) held in Budapest in 1999.

The purpose of the symposium was to critically reflect on one of the recommendations from the WCS – that the ethics of science should be included in science and engineering university training programmes – by discussing four educational questions related to this recommendation:

- Why should ethics be taught to science and engineering students?
- What kinds of problems are to be dealt in the ethics teaching?
- What ethical norms and principles are to be taught?
- How should the individual student relate to these norms and principles?

In this paper these questions are discussed. The content of the paper is the responsibility of the author alone, and does not reflect a consensus position of the symposium participants. However, the structure and content of this paper is influenced by the interventions by and discussions among the symposium participants, and hence serves as the symposium report. Most of the

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presentations delivered at the symposium dealt with specific ethics courses taught to science or engineering students by the presenter, and it is not the purpose of this paper to discuss these courses. Rather I shall extract from the symposium discussions general points of validity outside the specific course context. The programme of the symposium and the list of participants are included as appendices. The articles, papers and power point presentations dealt with during the symposium, are available for download at the symposium website (www.teachingethics.dk).

1 The Teaching of Ethics

For more than 35 years UNESCO has hosted initiatives that aim at understanding the current ethical problems raised by scientific and technological progress.² Initially the focus of UNESCO's ethics division was ethical issues emerging from the life sciences (bioethics), but in 1998 the division was expanded to also cover science and technology ethics in general as well as environmental ethics. Today UNESCO's ethics division consists of five overlapping programmes, the Bioethics Programme, the Ethics of Science and Technology Programme, the Ethics Education Programme, the Global Ethics Observatory Programme, and the Ethics Around the World Programme. UNESCO's activities in the area of ethics and ethics education fall into three categories:

- *Standard-setting actions.* E.g. the Universal Declaration on the Human Genome and Human Rights, which was endorsed by the United Nations General Assembly in 1998; and the International Declaration on Human Genetic Data, which was adopted by the UNESCO General Conference at its 32nd session, 2003. In February, 2005, UNESCO's International Bioethics Committee (IBC) presented a Preliminary Draft Declaration on Universal Norms on Bioethics. Currently UNESCO's Division of Ethics of Science and Technology, in cooperation with The World Commission on Ethics of Scientific Knowledge and Technology (COMEST), has studied the issue of an ethical code of conduct for scientists. The Director-General of UNESCO has proposed to the forthcoming 33rd General Conference to initiate a feasibility study regarding an international declaration on science ethics that can serve as a basis for a code of conduct for scientists.
- *Capacity building.* UNESCO's ethics division is setting up databases on experts, institutions and teaching programmes in science and technology ethics, and national legislation and ethical guidelines structuring activities of science and technology (the Global Ethics Observatory); and initiating and reinforcing educational activities for the teaching of ethics to (future) scientists and engineers (the Ethics Education Programme).
- *Awareness rising.* Conferences, meetings and workshops are organized (e.g. Ethics Around the World) and publications published (such as the

² The following four paragraphs are based on two sources: the website www.UNESCO.org/ethics and the presentation "UNESCO, Ethics and Ethics Education" delivered by Henk ten Have at the symposium *Teaching Ethics to Science and Engineering Students*, Copenhagen, April 15 - 16, 2005.

report “The Teaching of Ethics”³ and the UNESCO book series: “Ethics of Science and Technology”).

COMEST was set up in 1998 as science and technology ethics was put on the agenda of UNESCO’s ethics division. The purpose of COMEST is to give advice to UNESCO and its members on ethical issues related to science and technology.⁴

In August, 2003 COMEST issued a report entitled “The Teaching of Ethics.” The report discusses how a scientist *can maintain high standards of scientific integrity and quality control when the relationships between the researcher and other actors such as universities, the state, corporations and international trade organizations are changing? How can one increase the young scientist’s ability to distinguish right from wrong and to feel social and environmental responsibility?*⁵

“The teaching of ethics”-report is a follow-up initiative to the 1999 WCS. Point 71 in the plan of action, agreed upon at this conference, states: *The ethics and responsibility of science should be an integral part of the education and training of all scientists. It is important to instil in the students a positive attitude towards reflection, alertness and awareness of the ethical dilemmas they may encounter in their professional lives. Young scientists should be appropriately encouraged to respect and adhere to the basic ethical principles and responsibilities of science.*⁶

The WCS recommendation raises many educational questions, which deserves a thorough scholarly debate. In the following sections of this paper four such questions are discussed. I begin by reflecting on the purpose of teaching ethics to science and engineering students.

2 Why Teach Ethics?

In the introduction to the COMEST report “The Teaching of Ethics” it is stated that: *Today most people agree that one must establish good strategies for securing sustainable development. The teaching of ethics [to science and engineering students] can play a decisive role in the work for sustainability. Ethical values are the principle factor in social and, at the same time, the most effective agent of change and transformation.*⁷ In other words, in the COMEST report one of the overall arguments for including ethical elements into science and engineering curricula is that it is part of a strategy for securing sustainable development and betterment of the human condition.

³ Cf. below.

⁴ http://portal.unesco.org/shs/en/ev.php-URL_ID=6193&URL_DO=DO_TOPIC&URL_SECTION=201.html.

⁵ “The Teaching of Ethics”, The World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), 2003, p. 2. Available at http://portal.unesco.org/shs/en/ev.php-URL_ID=3568&URL_DO=DO_TOPIC&URL_SECTION=201.html.

⁶ Ana Maria Cetto (ed.): “Proceedings of the WCS”, UNESCO, 2000, p. 482. Available at <http://www.unesco.org/science/wcs/> -> “Proceedings...”

⁷ “The Teaching of Ethics”, p. 2.

A similar purpose statement for teaching ethics to science and engineering students is presented in the background paper for the WCS, "Ethics and the responsibility of science", prepared by ICSU's Standing Committee on Responsibility and Ethics in Science (SCRES). Science and technology can help *to move towards a more sustainable biosphere that is simultaneously economically feasible and ecologically sound. Many in the scientific community demand that this sustainable biosphere should also be socially just.*⁸ Later in that paper, it is recommended that the teaching of ethics in scientific education be strengthened to achieved this purpose.

The teaching of ethics to science and engineering students should *start from the assumption that [scientists and] engineers, both individually and collectively, aim to contribute positively to human well-being through their professional work and/or that they want to perform their professional activities in an ethical and socially responsible way,*⁹ as Henk Zandvoort puts it.

It is my impression that the majority of the participants in the Copenhagen Symposium agreed that science and engineering students ought to be taught ethics as part of a strategy aimed at securing a sustainable and socially just world.

In the symposium discussions it was proposed that the inclusion of ethics in science and engineering curricula also reflects a desire to strengthen the individual moral of future scientists and engineers – to encourage them to behave decently. Today, this also has a global aspect, as the decisions taken by individual engineers and scientists can have consequences that reach far in space and time. During their training, scientists and engineers must develop a value system that directs their professional actions in a sustainable and socially just direction. Hence, the teaching of ethics should have this as its overall pedagogical ideal. A scientist or engineer acts in an ethical or socially responsible way if he or she does not violate certain ethical principles, and directs his or her research in a sustainable and socially just direction.

It is not obvious that teaching ethics to future scientists and engineers will lead to sustainable development and betterment of the human condition. As I see it, this initiative must be seen as a part of a larger web of actions inside many fields that taken together move the world in a sustainable direction. Neither is it straightforward to establish or formulate the ethical principles that define socially responsible behaviour, nor is it self-evident how students should relate to these values: Should they primarily internalise values and act according to them? Or critically reflect on these values?

One can also question that ethical values can stand alone in ethics curricula for science and engineering students, and argue that the ethical values be comple-

⁸ "Ethics and the responsibility of science", ICSU's Standing Committee on Responsibility and Ethics in Science (SCRES), 1999. Available at <http://www.unesco.org/science/wcs/background/ethics.htm>.

⁹ Henk Zandvoort: "Good engineers need good laws", in *European Journal of Engineering Education*, Vol. 30, No. 1, 2005a, p. 21.

mented with insight in and tools for changing existing power structures: Ethics teaching should not only focus on identifying and justifying adequate moral values – also the (potential / future) materialisation of such values, in the real world, should be addressed.

3 Epochal Typical Problems

The process of formulating the basic principles and responsibilities of science can begin by analysing what Wolfgang Klafki calls epochal typical problems.¹⁰ In the current epoch, Klafki argues, we need to address certain serious global problems. If we fail to handle such problem-clusters, the world as we know it will dissolve one way or the other, and not stay connected as a greater whole.

Klafki identifies five such complexes of problems: The peace question seen in the light of weapons of mass-destruction, environmental degradation approached as a global problem, social inequality viewed as a socially and globally constructed phenomenon, the digitalisation and automation of the production machinery system and its potential consequences in form of unemployment etc., and finally the increasing individuality and the related breakdown of the feeling of solidarity and social responsibility.¹¹

From the analysis of epochal typical problems one can extract or formulate basic ethical principles, which can guide scientists and engineers in handling these problems. The aim of such analysis is the formulation of appropriate ethical values and principles. This approach can also be used when science and engineering students are taught ethics. Bringing ethics home to students through real examples were by symposium participants seen as important. Hence, teaching ethics to science and engineering students starts by analysing aspects of epochal typical problems, and ends up with ethical value systems, and thereby, to some extent, contradicts conventional ethics teaching, where the main ethical theories (i.e. consequentialism, utilitarianism, virtue ethics, deontological theories and contractualism) are initially presented, and their use then illustrated on exemplary examples.

At the Copenhagen Symposium on Teaching Ethics to Science and Engineering Students elements of two epochal typical problems were presented and discussed: Chemical boomerangs and the military-industrial complex' infiltration of contemporary techno-science in the UK.

3.1 Chemical Boomerangs

Valery S. Petrosyan stated in his keynote presentation at the Copenhagen Symposium on Teaching Ethics to Science and Engineering Students – entitled

¹⁰ Wolfgang Klafki: "Neue Studien zur Bildungstheorie und Didaktik", Weinheim: Verlagsgruppe Beltz, 1996. In this paper I have used the Danish translation of Klafki's book: "Dannelses-teori og didaktik – nye studier", Århus: Forlaget Klim, 2002.

¹¹ *Ibid.*, pp. 73-78.

“Ethics in Teaching Chemistry and Chemical Safety” – that chemistry is a key science for life and social development. Not only do people, animals and plants consist of chemical elements and compounds. Also the materials used by human beings are natural or manmade chemicals. However, chemical compounds can, at certain concentrations, stress the human body as well as ecosystems. Hence, we can define chemical safety as when *the effects of organic, inorganic and organometallic ecotoxicants [i.e. chemicals] are at an environmentally safe level that allows the preservation of health of people and biodiversity of ecosystems.*¹²

Chemical boomerangs are chemical compounds that have negative toxicological and ecotoxicological effects, and hence potential contaminants of air, water, sediments, soil, plants, animals and humans. The poisonous “Dirty dozen” of Persistent Organic Pollutants’ (POP’s) and the New Priority Toxic Substances are examples of chemical boomerangs. Representatives of both groups of substances are / were produced as pesticides and other kinds of industrial products, but similar poisonous chemicals have also emerged unintentionally as bi-products or as a result of decomposition. Chemical boomerangs are dialectical: As in the case of DDT and similar pesticides, chemical boomerangs often have specific beneficial purposes at the same time as being dangerous due to their toxicity and ecotoxicity – a trait that depends on the prevalence of the substance in the environment. Both the beneficial uses and especially the hazardous properties of chemical boomerangs can hardly be said to be the result of individuals’ actions. Their good and bad qualities are consequences of systematic use.

When chemical boomerangs have been identified, and their negative toxicological and ecotoxicological effects are understood, little or no ethical competence is needed to realise that such compounds should not be “globalised” (i.e. spread around the globe) and used in ways and quantities that systematically harm humans or ecosystems. But how do we discover the toxicity and ecotoxicity of chemical compounds at a pace that can match the pace at which new chemical substances are introduced in the environment? How do we predict the accumulation of chemical boomerangs in the environment when the accumulation only can be established as a scientific fact after accumulation has taken place? *Thus the traditional scientific inputs have become ‘soft’ in the context of ... ‘hard’ value commitments.*¹³

The ethical issues emerging from the case of chemical boomerangs give rise to reflections within the political and the scientific spheres. Decision-makers need to allocate resources so that the negative toxicological and ecotoxicological effects of chemical boomerangs can be mapped and analysed. They must be willing to ban toxic and ecotoxic substances, which to some extent already is taken place on the national, on the regional (i.e. the EU chemicals legislation REACH, which was adopted by the European Commission in October, 2003) and on the international level (i.e. the Stockholm Convention of May, 2001); and even legislate on behalf

¹² The quotation is taken from Valery S. Petrosyan’s power point presentation “Ethics in Teaching Chemistry and Chemical Safety” at the symposium *Teaching Ethics to Science and Engineering Students*, Copenhagen, April 15 – 16, 2005.

¹³ Silvio O. Funtowicz and Jerome R. Ravets: “Science for the post-normal age”, in *Futures*, 25, 1993, p. 751.

of the precautionary principle, which states that legislators are required to take *protective* measures even if knowledge about cause and effect is limited.

Scientists must be willing to investigate questions related to the toxicity and ecotoxicity of chemical boomerangs, challenge chemicals legislation and the public discourse thereabout, disseminate their findings to politicians and the public, and get involved in methodological debates regarding the measurements and scientific investigation of 'soft' facts. In other words the ethical issues emerging from chemical boomerangs are primarily related to legislation, resource allocation and epistemology.

3.2 Soldiers in the Laboratory

In 2004 "Scientists for Global Responsibility" – an UK based organisation that promotes ethical science and technology – commissioned researcher Chris Langley to investigate the influences of the military on science, engineering and technology. In the report "Soldiers in the Laboratory", Langley notes – with reference to John Ziman's understanding of contemporary techno-science – that [t]he world of scientific investigation has changed over the past twenty years:¹⁴

- Scientific knowledge creation and its applications at universities and in small private R&D companies are being collectivised; i.e. it is carried out by larger inter-institutional groups, networks or consortia rather than by individuals.
- Funding policies of science, engineering and technology have changed. Commercial objectives and short-term utility expectations are now central, rather than the pursue of truth for its own sake.
- Techno-scientific activities are becoming more project-oriented, as the research funding structure now primarily supports specific and well-demarcated R&D projects. Research projects are being funded ad hoc. The competition between the consortia over research funding is tough.

If a young scientist or engineer wants a research carrier, his or her chances for success are highest if (s)he gets enrolled in a research network that subjugates its research activities the agenda of a funding source.

This new techno-scientific mode of operation has an influence on our understanding of the ethics of techno-science. Scientists are not only required to produce credible knowledge, as Merton's CUDOS set of norms commits to.¹⁵ The ethical nature of the research aims, promoted by funding agencies, becomes central. [I]n case of development of science towards techno-science the ethics of science becomes more and more an ethics of scientific responsibility, as László Molnár

¹⁴ Chris Langley: "Soldiers in the Laboratory", Scientists for Global Responsibility, 2005, p. 15. John Ziman: "Prometheus bound: Science in a steady state", Cambridge: Cambridge University Press, 1994.

¹⁵ Tom Børsen Hansen: "The Ethics of Science", in *INES Newsletter*, No. 45, May, 2004.

eloquently puts it.¹⁶ Molnár also notes that if techno-science is only viewed as a kind of economic (market) activity moral norms can be excluded by this kind of scientific activity.¹⁷ “Soldiers in the Laboratory” exemplifies this problematique, as it documents that approximately 30 % of the public research funding in the UK is allocated to research programmes of military relevance. Since 2002 the British government has launched several funding programmes that (co)-finance inter-institutional consortia working with military research and development projects:

- The Joint Grant Scheme. *The UK research councils..., to with the Ministry of Defence, offer a Joint Grant Scheme to support research which has defence relevance.*¹⁸
- *Defence and Aerospace Research Partnerships are industry-led university partnerships... funded by the Engineering and Physical Sciences Research Council, Department of Trade and Industry and Ministry of Defence as well as industry.*¹⁹
- Towers of Excellence and Defence Technology Centres. Both Ministry of Defence programmes that fund collaboration between public military research laboratories, universities and military industries.²⁰

These military funding initiatives promote a narrow security agenda based predominantly upon the idea that security is achieved through military superiority. Langley finds this understanding of security improper, as [g]lobal security today faces more challenges from terrorist groups than from nation states. Furthermore military research funds can divert resources from, for example, research programmes that aim at promoting public health, revoking poverty or securing energy sustainability.²¹ In short Chris Langley argues that research funding should rather be spent on creating a secure and safe world than on developing new weapons. He mentions the NATO science programme “Security through Science” as an example of research funding mechanism that promote a broader security agenda.²²

As the new mode of techno-science closely links scientific and engineering activities to the interests and value systems of research funding sources, the choice of research projects becomes ethically important. Hence, scientists and engineers’ choice of research projects essentially is an ethical action. However, to give the choice of research projects an ethical dimension, the construction of an ethical orientation system, which can guide the individual’s choice of research involvement, becomes paramount.

¹⁶ László Molnár: “Some Remarks on Tom Hansen’s Article *The Ethics of Science*”, 2005.

¹⁷ *Ibid.*

¹⁸ Langley 2005, p. 42.

¹⁹ *Ibid.*, p. 43.

²⁰ *Ibid.*, pp. 44-45.

²¹ *Ibid.*, pp. 64-72.

²² *Ibid.*, p. 47. See also <http://www.nato.int/science/>.

One cannot expect scientists or engineers to give up their scientific careers if ethical choices cannot be made. Under such circumstances the ethical factor becomes political as the distribution of research funding needs to be changed so that scientists and engineers actually can choose to get involved in projects that are ethically sound. If scientists and engineers systematically have the experience of not being able to get involved in ethical projects, one can hope that they will organise politically and try to change this state of affairs. Ethical training of researchers could be organised in a way that provide them with the insight needed to do so. The techno-scientific endeavour is being collectivised. This means that the ethical 'subject' of contemporary science and technology becomes a collective one.

4 Ethical Theories

The COMEST report "The Teaching of Ethics" suggests that [s]ome main types of ethical theories, their strengths and weaknesses, particularly consequentialism, utilitarianism, virtue ethics, deontological theories and contractualism²³ are taught to science and engineering students. The rationality behind this suggestion is that knowledge of these main ethical theories will help students to develop 'competence in ethics', which has to do with being able to decide what is the right - or the wrong - thing to do in a given situation, by balancing the arguments that support a given action with the arguments that talk against it.²⁴

An ethical argument usually refers to a specific value, norm or principle. Competence in ethics will, if developed, equip science and engineering students with a tool that can help to resolve ethical dilemmas relevant to their (future) professions, and hence, hopefully guide them to choose a course of life they can defend ethically. Also it can help students to understand the policies and strategies that politicians and company leaders follow.²⁵

However, the main ethical theories cannot stand alone in ethics curricula for science and engineering students if the aim of including ethics courses in science and engineering study programmes is securing sustainable development and betterment of the human condition. Two elements are lacking: Ethical theories that explicitly deal with global epochal typical problems, and insight in and critique of the full set of rules and regulations (including company rules as well as national, regional and international legal systems) that affect the freedom of action of an individual or a corporation.

4.1 Global Ethics

In his book "The Imperative of Responsibility" German philosopher Hans Jonas criticises the main ethical theories for not being useful in handling epochal

²³ "The Teaching of Ethics", p. 7.

²⁴ *Ibid.*, p. 5.

²⁵ Cf. Finn Arler's power point presentation "Teaching ethics to planners and engineers" delivered at the symposium *Teaching Ethics to Science and Engineering Students*, Copenhagen, April 15 - 16, 2005.

typical problems created by the techno-scientific development. The human condition has changed dramatically with the growing importance of techno-science in modern societies. This changed condition gives rise to a new ethics for the technological age. The ethics of the 'old' age [i.e. the main ethical theories] is, according to Jonas, characterised by being anthropocentric, as only 'human to human' actions have been given ethical significance. Human's attempts to control our surroundings (nature) were considered a triviality, and the essence of humankind taken for constant and unchangeable.²⁶

Now a new imperative has emerged: *Act so that the effects of your actions are compatible with the permanence of genuine human life.*²⁷ This imperative, which differs from the main ethical theories that has the individual will as main reference, *addresses itself to public policy rather than private conduct, which is not in the causal dimension to which that imperative applies.*²⁸ Another difference between the new and the old imperative is that the new imperative *adds a time horizon to the moral calculus.*²⁹

*"The existence of humankind must never be put at stake". Herewith we have at last found a 'principle' that forbids certain technologically feasible "experiments".*³⁰ Jonas warns us against two types of potential unethical developments. *Never must the existence or the essence of [humankind] be made a stake in hazards of action.*³¹

If we can agree with Hans Jonas that the responsibilities and ethical principles of science are not merely a matter of individual preference, we see that the ethical principles of techno-science require institutionalisation. Going back to Petrosyan's analysis of chemical boomerangs and Langley's reading of the military-industrial complex' involvement in the science, engineering and technology, the ethics of techno-science is not only a matter of individuals' choosing ethical research projects. The ethical issue also encompasses a political approach to current public and private research priorities. Hence, the current research funding systems must not be reified in its current form. It must be changed according to the Imperative of responsibility. (Cf. Langley's plea to change the current research priorities so as to address the urgent problems facing humanity: Food security, clean water, the resurgence of infectious diseases, poverty, climate change and so on.)

The starting point of Peter Kemp's keynote lecture at the Copenhagen Symposium on Teaching Ethics to Science and Engineering Students, entitled "Cosmopolitanism in Ethics and Law", and for his reflections in his new book "The Cosmopolite as a Pedagogical Ideal" (in Danish)³², is Ulrich Beck's idea that

²⁶ Hans Jonas: "The Imperative of Responsibility. In Search of an Ethics for the Technological Age", Chicago and London: The University of Chicago Press, 1984, pp. 4-5.

²⁷ *Ibid.*, p. 11.

²⁸ *Ibid.*, p. 12.

²⁹ *Ibid.*, p. 12.

³⁰ *Ibid.*, p. 37.

³¹ *Ibid.*, p. 37.

³² Peter Kemp: "Verdensborgeren som pædagogisk ideal", Copenhagen: Hans Reitzels Forlag, 2005.

cosmopolitanism will be the next great narrative, and thus replace nationalism, communism and neo-liberalism as such.

The cosmopolitan vision states that the well-educated individual understands him- or herself as citizen in two societies: in the nation state in which the citizen is born or admitted into, and the world community that he or she is a part of merely as belonging to humankind.

Also for Kemp the emergence of what Klafki's calls epochal typical problems shows that we must think in a cosmopolitical way to survive, and he points out three such clusters of problems: Financial globalisation and difficulties related to democratic control of economic and technological development, the clash of national / cultural consciousness and global responsibility, and threats to sustainable development: Consumption of resources, pollution, hunger, epidemics and unwholesome foods.

Kemp attempts to set up a pedagogical ideal that can guide the formation of world citizens. Each of us has to realize, via our formal and informal education (i.e. the process that forms us as human beings), that we are part of a greater whole: Humanity. Schools, universities, and other educational institutions must be organised as to promote such a process of formation. Hence, cosmopolitan 'bildung' is seen as a necessary element in the solution-mechanism of epochal typical problems. Other elements in such a solution schedule are international law, that holds the nation state as its legal subject, and 'cosmopolitan law', whose legal subject is the individual.

4.2 Goods Laws

Henk Zandvoort addresses the relations between ethical principles, and national and international law as well as company rules. In the paper "Good engineers need good laws" Zandvoort shows how the principle "Engineers and scientists shall inform the public of the possible consequences of their work" is met by severe legal obstacles, as [1] *labour contract law forbids employees to disclose facts concerning their employer's business that the employees 'ought to keep secret'. Violation is a legal ground for dismissal.*³³

A whistleblower is a person who publicly reveals wrongful or unscrupulous actions in his or her working environment, or discloses suppressed and distorted information regarding threats against human health and environmental harm. When a person blows the whistle (s)he often breaks a confidential agreement, or other aspects of labour contract law. Hence, a whistleblower easily risks losing his or her job. When strong financial or national interests are threatened by a whistleblower's disclosure, harassment might also take the forms of imprisonment, personal persecution or slander.³⁴

³³ Zandvoort 2005a, p. 22.

³⁴ Hansen 2004. Armin Tenner: "Whistleblowers", in *INES Newsletter*, no. 43, 2003.

Normally engineers and scientists work as employees within a hierarchical organisation. This not only limits the individual's freedom of speech, it also transfers the responsibility for the consequences of research and development to the superiors. Hence, it seems appropriate to hold corporations or consortia rather than individuals inside a corporation or consortium responsible and liable for R&D activities. Zandvoort analyses an array of examples of technological harm and risks, which he shows has the structure of a prisoner's dilemma.³⁵ He notes that prisoner's dilemmas may be solved by introducing collectively approved rules and by appointing an umpire who is given a mandate to check that these rules are abided by and to impose sanctions when they are violated,³⁶ and illustrates how existing legal systems fail to solve these dilemmas. He points to a potential alteration of the legal systems, which might resolve prisoner's dilemma situations related to sustainability and technological risk: Corporations should be unconditionally liable for the possible consequences of [its] actions unless those who may suffer these consequences have given their informed consent.³⁷

These reflections have, according to Zandvoort, implications for the kind of ethics that has to be taught to science and engineering students. Courses in science and engineering ethics should give systematic attention to the critical analysis of *the function and presuppositions of the legal system, including ethical foundations and including a critical assessment of how well the actual legal systems perform their functions, and of the prevailing systems and procedures of collective decision-making.*³⁸

5 The Individual Student

Veikko Porra has set up a model for how individuals form their personal moral principles.³⁹ Porra distinguishes between our private *internal* moral principles, and the *external* norms carried by various social groups and institutions surrounding and affecting us. The internal moral principles of, say, a scientist or an engineer might be influenced by the workplace's set of values, code of conducts etc., upheld by an engineering or science association or union. If the engineer or scientist is religious or politically active his or her ethical orientation system might also be affected by the values entangled in activities of a given church, party or NGO. Family members, colleagues at work and other fellow citizens also influence the internal values of a person.

Porra's perspective to teaching ethics to science and engineering students seems similar to that of John Ziman: *In practice, however, science students are not amoral beings, brought up in an ethical vacuum. They are the products of a lively, articulate, moralizing culture. They have already acquired from home, school, church, the media and*

³⁵ Zandvoort 2005a. Henk Zandvoort: "Globalisation, environmental harm, and progress. The role of consensus and liability", in *Water Science and Technology*, 2005b.

³⁶ Zandvoort 2005a, p. 28.

³⁷ *Ibid.*, p. 28.

³⁸ *Ibid.*, pp. 34-35.

³⁹ Veikko Porra: "A Phenomenological Approach to Ethics Education", paper presented at the *International Conference on Engineering Education and Research "Progress Through Partnership"*, Ostrava, Czech Republic, 27 to 30 June 2004.

*their peers a set of rules of conduct that will carry them more or less successfully through the challenges of life. These may be mere conventions, mere maxims, mere rules of thumb, with no deep foundations. They are often logically inconsistent. People love animals and eat meat. They pity the poor and buy themselves luxuries. They pray earnestly for peace and go to war. But these happen to be the ethical principles that they have and hold. It is not within our power as teachers - especially as science teachers - to try to change them.*⁴⁰

Here I might add that the teaching of ethics to science and engineering students also can be seen as having an influence on the internal moral principles that the students come to hold. Scientists and engineers are, of course, not expected just to copy the values presented to them by their ethics teacher. What is of importance is the individual construction of a set of ethical principles, which can guide the individual in his or her professional carrier.

Porra suggests that scientists and engineers learn ethics by analysing the external moral norms carried by social groups and institutions surrounding and affecting scientists and engineers. In ethics classes questions that deconstruct involved actors' stand on certain topics could be asked: Which actors hold strong views on a given issue? What interests are embedded in these views? This approach can easily, but need not, be combined with a focus on epochal typical problems.

Values entangled in scientists' and engineers' work can deal with the quality of the work, i.e. expand quality criteria for the scientific or technological production. Merton's ethos of science is an example of such a set of values, which can be called *epistemic*. The values involved can also be *moral* i.e. regard the effects of a given piece of technology or scientific result on individuals, social groups, future generations, the environment etc. Hans Jonas' imperative of responsibility is an example of a moral value.

The teaching of ethics to science and engineering students must help them to set up a set of epistemic and moral values. But education is also about socialisation, about transgressing the self in the direction of something bigger. The rector of the Danish University of Education, Lars-Henrik Schmidt, states that this transgression can take place in two ways:

- Apollonian transgression of the self: *corresponds to the mind rising from the roots through a tree's trunk - the individuality - and thereafter transcends the tree via the top. The top forms, together with other treetops, a forest. The trees are interconnected.*⁴¹
- Dionysian transgression of the self: Here one does not wipe out (part of) oneself. The self slips out - momentarily and horizontally. This is a

⁴⁰ John Ziman: "Getting Scientists to Think about What They are Doing", in Tom Børsen Hansen (ed.): *The Role of Philosophy of Science and Ethics in University Science Education*, Göteborg: NSU Press, 2002, pp. 33-34.

⁴¹ Lars-Henrik Schmidt: "Dannelse på ny - om det socialanalytiske perspektiv på velfærdssamfundets dannelses-former" in *Dansk Pædagogisk Tidsskrift*, no. 1, 1999, p. 39. I have translated the quotation from Danish to English.

movement where the self is forgotten. *There is no forest, but a line of single trees that hold hands, when they feel like it.*⁴²

The challenge of teaching ethics to science and engineering students is to bridge the Apollonian and the Dionysian transgression of the self. This transgression must be made in the process where science and engineering students set up their individual epistemic and moral framework. Students should not just copy and uncritically internalise the values preached to them by their ethics teachers. Neither should they be ignorant of the values possessed by social groups and institutions surrounding them. There might be very valid reasons for internalising some of these values, as well as to reject others.

6 Conclusion

The ethics of science and technology deals with how to solve the global problems of our times. How can science and technology contribute to create a peaceful world and secure sustainable development etc.? When this question is addressed it is seen that the ethics of techno-science cannot be reduced to a question of individuals' ethical choices. Epochal typical problems can only be solved on the structural level. Nor can the ethics of techno-science be separated from epistemology. Global problems are very complex and, hence, entwined with uncertainty.

The main argument advanced in this paper is that if the teaching of ethics to science and engineering students is seen as part of a strategy for securing sustainable development and betterment of the human condition, then the basic ethical principles and responsibilities of science, which the students are required to set up as part of their orientation system must refer to something more than the main types of ethical theories. Science and engineering students need also to get acquainted with global ethics (e.g. Hans Jonas' imperative of responsibility and cosmopolitanism), corporate rules as well as national and international legal regimes, and the power structures of science and technology (e.g. funding and decision mechanisms).

When science and engineering students learn ethics they should not copy the values of others, nor should they automatically reject well-established value-systems. Science and engineering students should build their own set of ethical principles, which can guide them in their professional carriers.

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⁴² *Ibid.*, p. 39. My translation.

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A Symposium Programme

Programme for

“Follow-up Symposium to the 1999 UNESCO / ICSU World Conference on Science: Teaching Ethics to Science and Engineering Students. Copenhagen, April 15 - 16, 2005”:

Friday, April 15, 14.30 – 18.00. 1st workshop session: Sharing experiences.

- Welcome. (Tom Børsen Hansen).
- Introduction to the COMEST report “The Teaching of Ethics” and other international initiatives that deals with teaching ethics to science and engineering students. (Lillian Eriksen).
- Presentations of ethics curricula from around the world. Advantages and disadvantages connected to different formats. Interventions by John Avery, Luis Emilio Bruni, Hartwig Spitzer, Henk Zandvoort, Claus Montonen.

Saturday, April 16, 10.00 – 12.30. Public lectures.

- Henk ten Have: “UNESCO's activities in the area of ethics and ethics education”.
- Valery S. Petrosyan: “Ethics in Teaching Chemistry and Chemical Safety”.
- Peter Kemp: “Cosmopolitanism in Ethics and Law”.

Saturday, April 16, 14:30 – 18:00. 2nd workshop session: Discussions.

- What is the purpose of teaching ethics to science and engineering students & which ethical theories are to be taught? (Veikko Porra, Tom Børsen Hansen, Finn Arler).
- Identifying cases potentially included in ethics curricula for science and engineering students. (Chris Langley, László Molnár).
- Measuring science and engineering students’ values and ethical competences. (Yasuhiro Oue).
- Future points for discussion, and plans for action.

B List of Participants

Finn Arler, Associate Professor, Department of Development and Planning, Aalborg University.

John Avery, Professor Emeritus, Department of Chemistry, University of Copenhagen.

Luis Emilio Bruni, Institute of Molecular Biology, University of Copenhagen.

Christian Coff, Research Director, Centre for Ethics and Law in Nature and Society, Copenhagen.

Steen Hyldgård Christensen, Herning Institute of Business Administration and Technology.

Carin Dackman, School of Technology and Society, Malmö University.

Xiangyun Du, Department of Development and Planning, Aalborg University.

Kathrine Krageskov Eriksen, Copenhagen.

Lillian Eriksen, Oslo.

Tom Børsen Hansen, Center for the Philosophy of Nature and Science Studies, University of Copenhagen and EC member, INES.

Henk ten Have, Director, Division of Ethics of Science and Technology, UNESCO.

Anders Frøslev Jensen, Center for the Philosophy of Nature and Science Studies, University of Copenhagen.

Erland U. Jessen, University College of Aarhus.

Peter Kemp, Executive Director, Centre for Ethics and Law in Nature and Society and Full Professor and Head of Department of Philosophy of Education, Danish University of Education, Copenhagen.

Chris Langley, ScienceSources Consultancy and Scientists for Global Responsibility, London.

László Molnár, Department of Innovation Studies and History of Technology, Budapest University of Technology and Economics.

Claus Montonen, President of INES and Acting University Lecturer, Department of Physical Sciences, University of Helsinki, Finland.

Yasuhiro Oue, Senior researcher, Teijin Pharma Limited and Part-time Lecturer, Tokyo Institute of Technology.

Valery S. Petrosyan, Full Professor and Head of Department of Chemistry, M.V. Lomonosov University; Full Member, Russian Academy of Natural Sciences; Rector, Open Ecological University, Moscow; and Council Member, INES.

Veikko Porra, Department of Electrical and Communications Engineering, Helsinki University of Technology.

Hartwig Spitzer, Professor, Institut für Experimentalphysik, Universität Hamburg.

Patrik Kjærdsdam Telléus, Center for Philosophy and Theory of Science, Aalborg University, Denmark.

Henk Zandvoort, Department of Philosophy, Delft University of Technology.