Academic and social responsibility of scientists

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'Science Agenda – Framework for Action', a document endorsed at the International Council for Science (ICSU) and UNESCO's 'World Conference on Science' in 1999, recommends that 'the basic ethical principles and responsibilities of science' be an integral part of the education and training of all scientists and engineers. However, within this document it is not clearly defined what exactly is to be understood by the phrase 'the basic ethical principles and responsibilities of science'. The aim of this article is to characterise a possible meaning of this phrase, emphasising the academic and social responsibility of individual scientists and engineers. In doing so, a model is presented and used. The model suggests that the ethics of science concerns three interacting levels: a normative level where ethical principles of science are set up, discussed, and justified; an individual level where the ethical principles are translated into responsible actions of individual scientists and engineers; and a structural or contextual level where the social institutions and mechanisms that surround the individual scientists and engineers are addressed.

Teaching ethics to science and engineering students

The document 'Science Agenda – Framework for Action', agreed upon at the International Council for Science (ICSU) and UNESCO's 'World Conference on Science' (WCS) held in Budapest in 1999, recommends that

> [t]he 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 [1].

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In other words, the future generation of scientists must learn to respect the so-called 'basic ethical principles and responsibilities of science'. One of the means to promote this objective is the inclusion of 'ethics and responsibility of science' into university science and engineering training programmes. It is noted that, at the moment, ethical aspects are rarely included in study programs educating scientists and engineers [2].

The ICSU/UNESCO document identifies UNESCO's World Commission on Ethics of Scientific Knowledge and Technology (COMEST) and the International Council of Science's (ICSU) Standing Committee on Responsibility and Ethics of Science (SCRES) as having a special responsibility to follow up on this issue [3].

One might imagine that science education research communities, and groups of scientists and engineers that work within the area of social and global responsibility of scientists – such as the Pugwash Conferences of Science and World Affairs (Pugwash) and the International Network of Engineers and Scientists for global responsibility (INES) – also hold important voices in the process of changing university science and engineering education to include ethical elements.

The follow-up initiatives of COMEST, born out of the recommendation of the WCS to include ethical aspects in university science curricula, produced the report titled 'The Teaching Ethics' issued in August 2003 [4]. The report asks how a researcher

> can maintain high standards of scientific integrity and quality control when the relationship 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 responsible? [5]

One of the means to do so is ethical training of science and engineering students, where the students will develop 'competence in ethics'.

Competence in ethics has to do with argumentation and offering a set of reasons or evidence in support of a conclusion. An argument is supposed to provide evidence, give us reasons to believe [6]. This competence will, if developed, equip science and engineering students with a tool to judge values and principles entangled with ethical issues/dilemmas relevant to their (future) professions. The COMEST report suggests that science and engineering students must learn the main types of ethical theories, that is, consequentialism, utilitarianism, virtue ethics, deontological theories and contractualism. If they do so, ethical competence will follow.

SCRES existed from 1996 to 2002. In addition to co-organising a session on science and ethics in the WCS, it prepared an empirical study of 115 existing ethical standards in science. The SCRES study identified existing inter-disciplinary and disciplinary ethical guidelines, codes of conduct, and principles that regulate science and engineering activities as constituting the basic ethical principles of science [7].

In the report from a symposium held in Copenhagen 2005 and organised by INES in collaboration with Center for the Philosophy of Nature and Science Studies at the University of Copenhagen, it is concluded that science and engineering students – in addition to what is mentioned above – need to

> …get acquainted with global ethics (e.g. Hans Jonas' imperative of responsibility and cosmopolitanism), national and international legal regimes, and the power structures (e.g. funding and decision mechanisms) of science and technology [8].

At the Second Pugwash Workshop on Science and Society, held in Ajaccio, September 10 to 12, 2004 – where an earlier version of this article was presented – the need to provide education on ethics and biosecurity to scientists was discussed. Rather than drawing conclusions, an array of questions was raised:

> Among the immediate questions raised were, whose system of ethics [are to be taught]? Who should teach? Is it possible to teach ethics without turning the instruction into ideological indoctrination? Who is to be responsible for such a course of instruction? Are there empirical studies of the impact of the courses that suggest such training would contribute to an improved environment of ethical practice? At what age should a person's ethical training start? [9]

The quotation from the proceedings of the WCS reproduced above hints that 'the ethics and responsibility of science' concerns three interacting levels: (i) a normative level in which basic ethical principles and responsibilities of science are set up, discussed, and justified; (ii) an individual level where the ethical principles are translated into responsible actions of scientists and engineers (cf. 'young scientists should …respect … the basic ethical principles and responsibilities of science'); and (iii) a structural or contextual level where the social institutions and mechanisms that surround the individual scientists and engineers are addressed, as these institutions sometimes fail to prevent 'the ethical dilemmas [scientists and engineers] may encounter in their professional lives.'

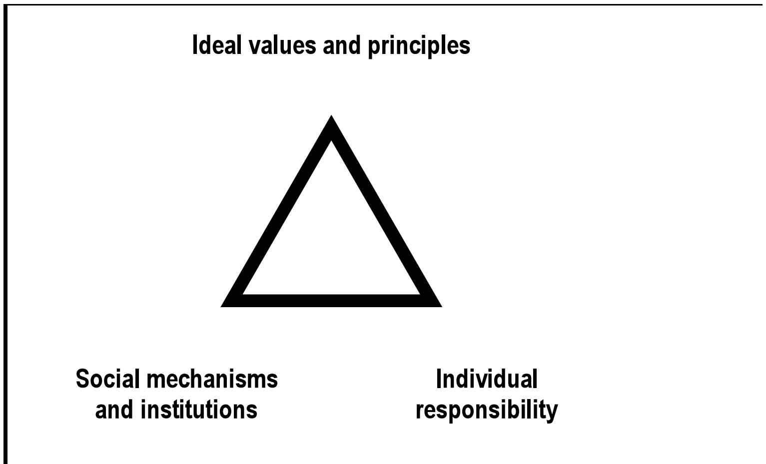

Figure 1. Analytical model used in this paper

The analytical model of this paper, which is illustrated by the triangle shown in figure 1, tries to capture this idea. It emphasises a dialectic between the responsibilities of individuals and the surrounding social institutions and mechanisms, which again is – or at least ought to be – influenced and co-formed by ideal ethical values and principles.

An ambiguity is present in 'Science Agenda – Framework for Action': Who holds responsibility? Is it 'scientists' or is it 'science'? (Cf. the phrase 'the ethics and responsibility of science'). This ambiguity is known from Oppenheimer's famous statement:

> In some sort of crude sense, which no vulgarity, no humor, no overstatement can quite extinguish, the physicists have known sin; and this is a knowledge which they cannot lose [10].

Oppenheimer talks about physicists as a 'collective'. So, who holds responsibility – individual scientists or collectives such as scientific communities? My answer to this question is: Both! Basic ethical principles guide both the formation of scientific institutions and the mechanisms that affect scientific practice and actions of individual scientists – especially when such institutions and mechanisms neglect the so-called basic ethical principles of science.

This interpretation of the 'Science Agenda – Framework for Action' document is in line with the recommendation of SCRES:

> We recommend that ethics in scientific education be strengthened. The ethical responsibility of the scientific community is ultimately borne by the individual scientists. It is she or he who decides how and whether to pursue a given line of research, what to do with the information obtained, and so on. This is not to say that the individual scientist will be fully responsible for, say, any applications of her/his results, many of which (s)he may have no power to influence, but that the ethical awareness of the individual scientist is of utmost importance. Ethical awareness is not just a matter of knowing what one considers morally adequate, but to be able to foresee and analyse elaborately different views on moral adequacy in various contexts, ultimately to form an informed opinion against that background. Ethics is more than an aspect of upbringing, it is a subject that requires studies for efficient use [11].

The ethos of science

Writings on scientific ethics sometimes focus on good scientific behaviour and set up norms and rules which should be followed by members of the scientific community in order to guarantee the credibility and truthfulness of scientific results or to discuss cases where established epistemic rules or norms are violated [12]. The archetype of good scientific behaviour is reflected in Merton's ethos of science, known under the acronym CUDOS [13].

In 1942 Robert Merton suggested that good scientific practice includes the sharing of scientific results with others, whereby everyone, whether an expert or a layperson, in principle, is able to test, challenge and use scientific results. Science is, in other words, 'communal'. Merton also argued that knowledge claims are to be tested against pre-established impersonal criteria. Science is 'universal'. The scientific communities were warned by Merton not to let their research projects be financed by power structures with special interests in the outcome of the scientific projects. Independence would, argued Merton, diminish external control and hence the distortion of scientific results. Science must be 'disinterested'. Finally Merton stated that scientists should not only be involved in the production of new knowledge; scientists are also committed to be critical towards scientific knowledge claims raised by their colleagues, and are obliged to test their colleagues' results. Hence, the peer review system plays an important part in the scientific endeavour. It gives scientific knowledge its reliability and validity, because independent peers have tested it. Science rests on 'organised scepticism'.

Merton's ethos of science is an ideal. Hence, both its formulation and justification are normative endeavours by nature. On the descriptive level it has co-formed existing scientific institutions, such as 'the scientific journal with peer review' and 'the university'. The British physicist and sociologist of science John Ziman calls knowledge production that follows the CUDOS norms 'academic science' [14].

According to Thomas Kuhn, academic science consists of two modes: 'normal' and 'revolutionary science' [15]. Normal science, which is the most predominant form of academic science, deals with riddle solving. Normal scientists compete in solving the riddles defined by the disciplinary matrix under which they work. Kuhn introduced the term 'the disciplinary matrix' in 1970, not as a substitute for a paradigm, but as a clarification [16]. Having introduced the disciplinary matrix, Kuhn described two meanings of the term 'paradigm'. The first defines a paradigm as a disciplinary matrix. Here the term is used in a broad, sociological sense to refer to the entire constellation of metaphysical beliefs, values, symbolic generalisations and techniques shared by members of a scientific community. The second, narrow sense, which according to Kuhn is the most fundamental, defines paradigms as exemplary past achievements and refers to concrete scientific solutions to scientific problems. Hence, normal scientists solve scientific riddles by using the symbolic generalisations (for example 'the laws of nature') that co-define the disciplinary matrix under which they work. The social dynamics of normal science is captured in what Henry H. Bauer calls 'the puzzle-and-filter method' [17].

When academic science is in a revolutionary mode, different paradigms compete in delivering the most adequate explanations of natural phenomena. It is, according to Kuhn, typically during scientific revolutions that new symbolic generalisations are formulated.

Today's academic scientific production is published in peer-reviewed scientific journals and books [18]. 'Peer review is a procedure or a system in which equals from the same scientific field, peers, evaluate the quality of the output, the scientific papers' [19]. (Cf. the norm of organised scepticism).

Scientific publications are – at least in principle – accessible at university libraries in paper or electronic form, whereby everyone can gain access to the fruits of science (cf. the norm of communism). Peers are expected to test the validity and reliability of knowledge claims raised in articles submitted to peer-reviewed journals, according to impersonal criteria (cf. the norm of universality). The identity of the peers and the contributor are made anonymous during the peer-review process. Hence it is not possible to favour knowledge produced by, for example, 'very important persons' (cf. the norm of disinterestedness).

Diverse points of criticism can be raised against the institution of peer-reviewed scientific journals. Commercial publishing houses, required to make a profit, publish many peer-reviewed scientific journals and books, which are becoming increasingly expensive. The increased price of scientific knowledge has fostered the criticism that the access to the fruits of academic science is restricted to the rich, though it must be admitted that not all scientific journals and publishing houses are commercial, nor that all journals or science books are expensive. Another point of criticism follows similar lines. It points to the fact that the language of scientific literature often is English, which favours native English speaking scientists.

Critics of the peer-review system have claimed that it is not without problems that peers themselves are scientists who are members of the same scientific communities as the researchers who submit articles to be reviewed. This promotes normal science as opposed to revolutionary science and makes interdisciplinary research results difficult to publish. (This is a variant of the so-called 'Matthew effect') [20]. Indeed the peer-review system does require homogeneity and consensus regarding what is recognised as scientific knowledge [21].

It has been pointed out that no mechanism is in service that guarantees the universality of the peer review. This lack might also jeopardise its disinterestedness, and the promotion of special interests might sneak into the review. As science becomes more specialised, it might become problematic to locate competent and disinterested peers [22].

Furthermore it is not always possible for peers to validate and test results published in articles. Sometimes it is impossible to reconstruct the generation process of empirical material (the 'Andrea Doria phenomenon'), which again opens up room for scientific misconduct in the form of fabrication or plagiarism. "The demands for a 'perfect' peer review are very costly and time consuming to meet" [23].

Scientists working at a university are required to publish – in peer-reviewed journals – or perish. 'Grants are awarded, research programmes are developed and researchers appointed on the basis of peer review' [24]. I would like to note here that the downside of this publish-or-perish principle is to systematically rush researchers to fabricate, invent or plagiarise empirical material.

Also applications to research positions at universities and doctoral theses handed in at universities are peer reviewed, though neither the identity of peers nor applicants/graduate students are kept anonymous.

The Danish philosopher Hans Fink has formulated what I elsewhere have called 'the ethos of the university' [25]. It consists of five principles:

- Close connection between research and university education
- Freedom of research. The freedom concerns the choices of
    - the research problem
    - the research process
    - the publication strategy
- Freedom of teaching
- Self-governance
- The unity of science

Finks's ethos of the university especially emphasises the CUDOS norm of disinterestedness and the principle of self-governance addresses the quality aspect of scientific knowledge.

Scientists working at universities are guided by the ethos of academic science. University scientists are paid to do disinterested research; they are expected to produce scientific insight for non-instrumental reasons. They are also expected to publish their findings in peer-reviewed journals. But university scientists are not only researchers. They are also teachers of students, advisors of politicians, consultants to companies, communicators to the public – and hopefully also responsible citizens, etc. These activities are also guided by sets of norms, which might contradict the ethos of science. Hence I do not imply that the producers of academic scientific knowledge in all aspects of their professional lives follow Merton's ethos of science, nor that scientific communities do not also encompass counter-norms [26].

The CUDOS norms have also co-formed other institutional mechanisms that structure the work of academic scientists: the principles of Good Laboratory Practise (GLP) [27], Good Clinical Trial Practise (GCP), and Committees on Scientific Dishonesty [28], etc.

The institutional mechanisms inspired by Merton's ethos of science adopt the distinction between 'the context of justification' and 'the context of discovery' suggested by Reichenbach in 1938 [29]. Scientific arguments need to be universally valid and reliable. The specific (social and psychological) context in which research results were obtained is considered irrelevant.

Originally this distinction was put forward to distinguish between the sphere of validity and reliability and the sphere of individual creativity. This distinction is important as it decouples the inter-subjectivity of scientific argumentation from the subjective process of construction.

However, the distinction between the context of justification and the context of discovery also decouples scientific argumentation from the selection process of problems that are to be scrutinised scientifically. This might be a problem if the distinction between academic science and its applications can no longer be up-held:

> [T]he distinction between pure [academic] and applied science is a remnant of the distant past when scientific research was completely divorced from day-to-day life, and practical applications that could have resulted from academic research were remote in time and space. It would take decades before an application was found, and then it would have been taken up by different people, mostly engineers, in polytechnics or industrial laboratories.
>
> Nowadays, the distinction is hardly discernible. Practical applications often follow immediately after scientific discoveries, and are pursued by the same people. University scientists are encouraged to do applied research, to enable them to be financially self-sufficient [30].

It is not straightforward to explain why academic science is mixing with its practical applications, but I think it is related to the fact that academic research is constantly in need of more and more funding [31]. The reason is partly that scientific instruments are becoming more sophisticated, and hence more expensive. Increased research appropriations on public budgets create high utility expectations. Academic science is exposed to an external pressure of becoming more instrumental.

Also intra-normal scientific forces might pressure academic science in an instrumental direction. The number of scientific sub-disciplines, which are in their phase of finalisation, is increasing. A sub-discipline is in a state of finalisation if the set of exemplary uses of its symbolic generalisations is almost fully developed. The result is that the focus of these sub-disciplines becomes more instrumental, as only few pure academic problems are left for scientists to solve.

Merton's ethos of science regards the context of justification, and sets up a mechanism that ensures that the quality of scientific knowledge claims corresponds to specific intra-scientific quality criteria. It poses no direct restrictions on which questions are to be scrutinised by academic science. If we also recognise that normal science is the most predominant from of academic science, (at least) four consequences follow:

The first one is that it is the scientists' fascination of solving scientific riddles that drives normal science forward. The second is that it is the scientific communities that identify which scientific riddles are most prestigious to solve. The third feature is that normal research does not aim at solving 'the really pressing problems, e.g. a cure for cancer or the design for a lasting peace, [which] are often not puzzles at all, largely because they may not have any solution' [32]. The fourth consequence is that ethical aspects are decoupled from the choices of problems undertaken by scientists doing normal science.

However, it does not follow that the ethos of science or the scientific peer review system constitute the only set of norms/mechanisms that ought to guide academic science. In a celebrated paper, Funtowicz and Ravetz distinguish between four kinds of scientific activities: 'core science' (equivalent to academic science), 'applied science', 'professional consultancy', and 'post-normal science' [33]. The latter category of scientific activities denotes an approach to handling problems characterised by both high system uncertainties and high decision stakes.

The point I want to make is that post-normal science indeed is aimed at handling 'the really pressing problems' (which Funtowicz and Ravetz call 'policy issues'), for example those of risk and environment. Without going into details of the features of post-normal science, I note that post-normal science is 'not merely politics or public participation' [34]. It is an activity that encompasses scientific input into the problem-solving strategy of 'the really pressing problems'/'policy issues', without reducing it to that:

> Out of all this must come a set of forecasts which will provide the scientific input to decision processes; these will contribute to policy recommendations that must then be implemented on a broad scale. But all the causal elements are uncertain in the extreme; to wait until all the facts are in, would be another form of imprudence [35].

When normal science is seen as part of a post-normal problem-solving strategy, it couples normal science and ethical aspects. Some scientific riddles are more important to solve than others, when they are used as part of a decision-making process aimed at promoting public health, disarmament, or sustainable development, etc. In the post-normal problem-solving strategy extended peer review communities identify relevant research questions. Also other kinds of mechanisms can be used to identify such key-questions.

Now I return to the analytical model of figure 1. So far I have argued that the CUDOS norms constitute the ideal of academic science, which again, and to some extent, is realised in the social mechanisms and institutions of academic science (for example peer-reviewed scientific journals). These institutions affect the actions of academic scientists, as they are rewarded or punished when they respectively act according or violate the rules of these institutions.

I have also argued that there is not always a one-to-one correspondence between the ethos of academic science and existing academic scientific institutions. And it is here where 'the academic responsibility' of scientists enters the picture.

When confronted with contradictions between the ethos of academic science and existing academic institutions, scientists have an academic responsibility to act according to the ethos of science, instead of according to the practises of the existing institutions (though this is properly not beneficial to their academic careers).

Let me exemplify this point by referring to the discussion of peer-reviewed journals. I argued that the commercialisation of the academic press, and the fact that they usually are written in English, might contradict the norms of communism and universality. As I pose this criticism, responsibility is put on my shoulders regarding where I submit my research papers. I ought not to publish papers in the most expensive and commercial journals, nor only publish in English. (My mother tongue is Danish, and I am responsible for keeping this language alive as a research language – at least until all congenial Danish citizens speak English.)

I also mentioned that there exist no institutionalised impersonal principles that guide peers. Thus the norms of organised scepticism and disinterestedness could be violated. When I myself act as a peer, this criticism commits me explicitly to formulate the principles after which I intend to carry out my peer review.

Academic scientists are responsible not to put their discipline above everything else. In other words, they are obliged to reflect on the boundaries of the ideals that constitute the guiding principles of their work – for example to reflect on the limits of the CUDOS ethos. When should, for example, my actions be guided by the ethos of science, and when ought complementary sets of norms guide my actions?

Earlier I mentioned that scientists working at universities have many functions. Hence university scientists should not always be guided by the ethos of science. (A student should be treated differently than a contributor to a peer-reviewed journal.) This kind of iconoclastic reflection does also apply to the research process. I question whether the CUDOS norms can determine the (social) relevance of research questions, and argue that Merton's ethos of science only regards the validity and reliability of scientific results. It ought not address the selection process of scientific problems that are to be treated by academic science.

Misuse of science

In the SCRES background paper for the WCS, 'Ethics and the responsibility of science', the issue regarding the choices of research problems that scientists work on is taken up:

> In exchange for public funding, scientists are committed to contributing to finding solutions to the most pressing problems in society today. Investment in science is predicated upon the expectation of some return to society. The question is, what? Much of the investment in science in this century has been motivated by wars (World Wars I & II, the Cold War, and numerous other military interventions). In a more peaceful world, other scientific returns would be expected. Most important is perhaps 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 [36].

A similar argument can be put forward regarding scientists funded by private companies. In both cases sponsors want 'value for their money'. The view expressed in the quotation is not necessarily in contrast to Vannevar Bush's social contract between science and society that defines the domain in which Merton's ethos of science applies [37]. It broadens up the perspective to also include other kinds of knowledge production. Bush's contract between science and society states that society through the state finances academic science and gives it autonomy to freely choose its research questions and methods, to set up university curricula and other recruitment mechanisms. In this way the state provides the fuel for the reproduction of academic science. In return for this fuel, the state expects that the scientific communities make their knowledge production available as a public commodity. As spin-offs of academic science, both democratic processes and economic development are said to be stimulated.

The list of examples where science and technology have benefited humanity is long. The improvement of our health, our food, our houses and our schools is based on scientific and technological achievements. Expressed more elegantly in the words of Sir Joseph Rotblat:

> Infectious diseases that killed so many in infancy and young age, are now a thing of the past. The average life-span has generally increased dramatically. Greatly improved techniques in agriculture have made it possible – at least potentially – to provide food for the world population, even though the world population has been growing very fast as a result of better health and hygiene. New industrial technologies applied in factories and mines have largely removed the drudgery and mindlessness of labour, as well as reducing working hours and increasing safety standards. The products of the new industrial technologies have also lessened the chores of day-to-day life, such as housing amenities, food preparation and materials for clothing. The fantastic progress in communication and information has given more and more people access to the great cultural achievements—to books, concerts, museums, as well enabling them to keep in touch with current events via radio, television and the Internet. All this has made it possible for them to be more actively involved in the life of the community, whether at local, national or world-wide level. Altogether, people nowadays are much healthier, more affluent, better educated and informed, and thus more disposed to live in peace with one another, than at the beginning of this century. And, as I said, all this came about mainly as a result of the application of science to day-to-day life [38].

Despite the positive impact on human affairs, science and technology are sometimes, deliberately or unintentionally, misused [39]. At the 1st Pugwash Workshop on Science, Ethics and Society, held in Paris in June 2003, this issue was discussed. This workshop's report states that

> [a] number of legitimate scientific research activities are of dual use, with both civilian and military applications, and in these cases an evaluation of whether to pursue them always has a moral element. One of the greatest concerns at present is biotechnology [40].

The focus of the work of the Pugwash Workshop Series on Science, Ethics and Society is not so much on the accountability of scientific results, as it is on deliberate or unintentional harmful applications of scientific discoveries. Hence this perspective on science adds something qualitatively new to the approach of Robert Merton. The premise for this perspective is, of course, that the scientific results in question influence the environment or society. When this is the case, social regulation of scientific activities becomes topical. Social regulation of deliberately or unintentionally misused of science is not only an intra-scientific responsibility (cf. Functowicz and Ravetz' concept of extended peer review), though scientific communities and networks have progressed substantially in this regard (cf. Kathinka Evers' report: 'Standards for Ethics and Responsibility in Science: An Analysis and Evaluation of Their Content, Background and Function' [7]).

The dialectic between individual responsibilities and appropriate mechanisms of social regulation provides us with a fruitful framework for dealing with the issue of the misuse of science. Scientists and engineers ought to choose not to get involved in creating or applying scientific knowledge associated with the development of, for example, new weapons; but if no social mechanisms are set up to prevent such applications, nothing much is gained at the accumulated social level. (If one scientist chooses not to do it, another one probably will).

The Chemical Weapons Convention (CWC) is an example of a social mechanism that has been set up by the international community to prohibit one 'important and very dangerous kind of weapons of mass annihilation, committing the State Parties to the destruction of the chemical-weapons stockpiles and the production facilities' [41]. The 'international community' refers to 175 national state parties, who have signed and ratified the convention. Scientific expertise plays an important role in the processes leading up to and ensuring fulfillment of the treaty. However, such scientific activities are not 'pure', and remain intimately entangled with politics.

The CWC also set up an 'ethics project', maintained by the Organisation for the Prohibition of the Chemical Weapons (OPCW), which tries to promote peaceful uses of chemistry. On the official website of the OPCW, the ethics project is described as follows:

> The Ethics Project seeks to develop links with academic research centres, educational and other relevant institutions and organisations, as well as entities affected by the Chemical Weapons Convention to promote an awareness of the ethical dimensions of the Convention [42].

In 2004 and 2005 the ethics project of the OPCW progressed substantially, as collaboration with the purely scientific organisation IUPAC was established. In July 2005 OPCW and IUPAC met twice to discuss education and outreach regarding chemical weapons. The objective was to increase awareness of the Chemical Weapons Convention and its requirements within the chemical scientific community, via integrating issues related to the CWC and its implementation into chemistry teaching and setting up appropriate codes of conduct of chemists and chemical engineers [43].

Other examples of international treaties, agreements and judgements that intend to regulate the selection process of scientific R&D projects are:

- Advisory Opinion of the International Court of Justice on the legality of nuclear weapons [44]
- Biological Weapons and Toxin Convention [45]
- Convention on Biological Diversity [48]
- Cartagena Protocol on Biosafety [46]
- Comprehensive Nuclear-Test-Ban Treaty [47]
- Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects [49]

- Convention on the Prohibition of the use, stockpiling, production and transfer of antipersonnel mines and on their destruction (Mine Ban Treaty or Ottawa Convention) [50]
- International Convention for the Regulation of Whaling [51]
- Montreal Protocol on Substances That Deplete the Ozone Layer [52]
- Stockholm Convention on persistent organic pollutants (POPs) [53]
- Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. (The Outer Space Treaty) [54]
- Treaty on the Non-Proliferation of Nuclear Weapons [55]
- United Nations Framework Convention on Climate Change. (The Kyoto Protocol) [56]

What kind of scientific insight and technological applications of scientific results can be characterised as desirable or ethical? The list above of treaties and agreements suggests that scientific knowledge and its applications ought to be peaceful and environmentally sustainable [57]. However, it must be noted that the selection of treaties included in the list above is to some extent coincidental (my knowledge of existing international conventions is limited) and normative (e.g. the WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights is not included in the list, as I do not consider it reflecting an ethical ethos [58], though the paragraphs 4 to 6 of the Doha Ministerial Declaration on trade-related aspects of intellectual property rights and public health do reflect a concern for the socially unjust distribution of the fruits of techno-science – an aspect which is neglected by international law) [59]. Only multilateral treaties have been included in the list, excluding for example the Threshold Test-Ban Treaty [60].

The SCRES identifies four areas of potential ethical concern that deserve a close investigation regarding their ethical underpinning [61]:

- Science crosses new borders, and hereby calls fundamental ethical views into question. This point focuses on the tension between 'good' and 'bad' uses of new scientific concepts, theories and methods. Who is to determine what is good or bad: Scientists? Politicians? The general public? The challenge is to construct a coherent ethical position that covers a wide variety of related issues.
- Science and Power. Here, the focus is on the interfaces of science with economic and political powers.
- Science, Welfare and Equity. This deals with the question whether science and technology should help overcome global inequalities. Attention is also put on the concepts of 'social responsibility' and 'justice'. What these concepts refer to differs depending on what type of society we talk about.
- Scientific Uncertainty. How can scientific idealisation and abstraction deal with problems characterised by high system uncertainties coupled with high decision stakes (e.g. ecological factors). This provides for new challenges with regard to ethical issues.

One might ask if an ethos, some set of basic ethical principles, has been formulated to which we can refer when we analyse these 'new' ethical dilemmas? In his book *Hope in a Dark Time: Reflections on Humanity's Future*, David Krieger has collected a number of declarations and statements that capture different aspects of an ethical ethos appropriate for dealing with the ethical dilemmas that have emerged from the techno-scientific development. The declarations and statements included in Krieger's book are the following [62]:

- Universal Declaration of Human Rights (adopted by United Nations General Assembly, 1948).
- The Declaration of a Global Ethics (discussed at the Parliament of the World's Religions in Chicago, 1993).
- The Earth Charter (formally launched in 1991 after a 12 years grassroots drafting process).
- The Russell-Einstein Manifesto (the moral foundation of the Pugwash conferences).
- Appeal to End the Nuclear Weapons Threat to Humanity and All Life (the appeal has been signed by many prominent leaders of our time and Nobel laureates).

One could add to the list the Groningen Manifesto (adopted by the Symposium *Sharing the Planet*, organised by the Dutch chapter of Pugwash) [63] and the Charter of Human Responsibilities (proposed by Alliance for a Responsible, Plural and United World) [64].

International law does not directly refer to the literature of philosophical ethics. Maybe this is caused by the fact that global ethics is not a huge ethical discipline, though it is growing (in 2003, for instance, Margaret Somerville was chosen as the first winner of the Avicenna Prize for Ethics in Science). Here I will argue that Hans Jonas' book *The Imperative of Responsibility* offers an appropriate ethical theory which could be used as a global ethical theory underpinning international law regulating techno-science.

Hans Jonas sets up an ethics for the technological age. The starting point of Jonas' theory building is the fact that 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 – an ethics for the technological age. The ethics of the 'old' age can, according to Jonas, characterised be characterised as follows [65]:

1. [A]ction on nonhuman things did not constitute a sphere of authentic ethical significance.
2. Ethical significance belonged to the direct dealing of man with man, including the dealing with himself: all traditional ethics is 'anthropocentric'.
3. For action in this domain, the entity 'man' and his basic condition was considered constant in essence and not itself an object of reshaping 'techne'.
4. The good and evil about which action had to care lay close to the act, either in the praxis itself or in its immediate reaction, and were not matters for remote planning.

Kant's categorical imperative is an example of an ethical ethos of the 'old' age. It says, in one of its formulations, 'Act so that you can will that the maxim of your action be made the principle of a universal law' [66].

Now, the traditional characteristics have changed, and a new imperative emerged:

> An imperative responding to the new type of human action and addressed to the new type of agency that operates it might run thus: "Act so that the effects of your action are compatible with the permanence of genuine human life"; or expressed negatively: "Act so that the effects of your actions are not destructive of the future possibility of such life"; or simply: "Do not compromise the conditions for an indefinite continuation of humanity on earth"; or, again turned positive: "in your present choices, include the future wholeness of Man among the objects of your will" [67].

Jonas' imperative differs from Kant's: The reference of Kant's imperative is the individual will, but 'the new imperative addresses itself to public policy rather than private conduct, which is not in the causal dimension to which that imperative applies' [68]. Another difference between the new and the old imperative is that the new imperative

> adds a time horizon to the moral calculus which is entirely absent from the instantaneous logical operation of the Kantian imperative: whereas the latter extrapolates into an ever-present order of abstract compatibility, our imperative extrapolates into a predictable real 'future' as the open-ended dimension of our responsibility [69].

Thus also knowledge-based forecasts about possible futures become an intrinsic part of the ethical endeavour.

In short: the existence of humankind must never be put at stake. "Herewith we have at last found a 'principle' that forbids certain technologically feasible experiments" [70]. Jonas warns us against two types of potential unethical developments. 'Never must the existence or the essence of man as a whole be made a stake in hazards of action' [71]. The ban against annihilation of humankind is the core of the Russell-Einstein manifesto of 1955:

> Remember your humanity, and forget the rest. If you can do so, the way lies open to a new Paradise; if you cannot, there lies before you the risk of universal death [72].

The presence of concepts such as medically [73] and genetically [74] enhanced 'normality' makes us aware of the possibility to change the essence of humankind.

International conventions related to scientific knowledge and its applications regard deliberate harmful applications of scientific knowledge. Future unintentional harmful consequences of the techno-scientific development can hardly be prevented via targeted laws and institutions.

To prevent such unintentional consequences, it has been suggested that policies be adopted in accordance with the so-called 'precautionary principle', which states that if the development of a technique includes a potential risk, development of that technique must be stopped even if its risks are not scientifically proven. This principle is referred to as the basis for the environmental policies of European Union and plays an increasing role in developing health policies as well [75].

An explicit manifestation of the precautionary principle is the EU moratorium on GMOs which was in effect from 1999–2003. Since the spring of 1998, no new GMOs had been authorised for planting or use in the EU. This 'de facto' moratorium was made 'official' at an EU Environment Ministers Council meeting in June 1999 when five Member States – Denmark, France, Greece Italy and Luxembourg – issued a declaration that they would effectively block new GMO approvals until the European Commission proposed legislation for traceability and labelling of GMOs and products derived therefrom.

Following the revision of the Deliberate Release Directive regulating the release of GMOs into the environment (Directive 2001/18/EC repealing Directive 90/220/EEC, adopted by the European Parliament in February 2001), these five countries, subsequently joined by Austria, again declared that they would not lift the moratorium until the issue of traceability and labelling was resolved. The moratorium had been consolidated by similar declarations from Germany (October 2001) and Belgium (December 2001) [76].

Another mechanism that might help prevent unintentional consequences of science and technology is the establishment of early warning committees [77]. At the 53rd Pugwash Conference on Science and World Affairs: Advancing Human Security – The Role of Technology and Politics, working group 5, discussing the issue of 'New Technology for Human Development and Security', recommended that

> [a] working group at the next year's Pugwash conference in South Korea on the topic "Early warning and preventive action on emerging technologies" should be established. Topics within such a working group could be: the character of the early warning institutions, and the scientific analysis of examples of potential threats from emerging technologies – downside consequences of nanotechnology, biomedical technology etc., and security and privacy issues related to ICTs (Echelon etc.). The analysis should include contextual aspects (commercial, religious, and ideological etc.) surrounding emerging technologies, as well as account for the epistemological and historical meta-assumptions on which they are built [78].

The successful design of early warning committees – capable of predicting harmful unintentional consequences of the techno-scientific development – is, however, not an easy challenge.

Before I turn to issue of 'the social responsibility' of scientists, let me sum up this section. Techno-science has societal impact, which its patrons are well aware of. The impact of science and technology on society is dialectical, i.e. good and bad. Above, I first addressed one of the corners of figure 1 – the social mechanisms that have been set up to handle the dialectic of scientific R&D. Then I turned to the second corner of the triangle, and discussed what kind of ethos (if any) is behind the social mechanisms of science. Hans Jonas' imperative of responsibility was introduced in this context.

So what kind of social responsibility of scientists is associated with what has been said so far? First of all, scientists and engineers are committed to conscientiously object to involvement in certain research projects. This might not be without personal sacrifice (cf. the 11 years of imprisonment of the Iraqi scientist Dr. Hussain Al-Sharistani after he refused to work on Saddam Hussein's weapons programme, to mention an extreme case) [79].

If Hans Jonas' ethical ethos is an appropriate one – and I think it is – then the social responsibility of scientists is closely related to their scientific competences and technological abilities. Again I turn to Sir Joseph Rotblat for an exact formulation. In an article entitled 'The social responsibility of scientists' Rotblat, with Sir Michael Atiyah (who succeeded him as president of Pugwash), put forward three points [80]:

- Scientists will understand the technical problems better than the average politician or citizen, and knowledge brings responsibility.
- Remember this, that you have knowledge and you are responsible for how this knowledge is properly used. Scientists can provide technical advice and assistance for solving the incidental problems that may emerge.
- Scientists can warn of further dangers that may arise from current discoveries. Scientists can form an international fraternity that transcends beyond natural boundaries, so they are well placed to take a global view in the interest of mankind.

To these points I want to add that scientists also are socially responsible to reflect on, and discuss, in the so-called 'international fraternity of science', the constitution of the ethical ethos that guide their actions. A socially responsible scientist or engineer also addresses how his or her ethical ideals are mirrored in codes of conduct and national, regional and international legal regimes. Existing codes, treaties, agreements and conventions might not be sufficient, and may well be in need of change, new ones might be required for handling the techno-scientific development or they may be (systematically) violated. Scientists hold a responsibility to raise their voices in these regards.

Whistleblowers

A whistleblower is a person who publicly reveals criminal or unscrupulous actions in his or her working environment, or divulges suppressed and distorted information about dangers to human health and the environment [81].

In Michael Mann's motion picture *The Insider*, the 'true' story of whistleblower Dr. Jeffrey Wigand is told [82]. After Dr. Wigand stops as head of a research and development department at the 'Brown and Williamsson Tobacco Company', he decides to go public with the suppressed information that Brown and Williamsson enhance the addictive effect of tobacco, not by spiking it with additional nicotine, but by manipulating it using ammonia-chemistry. The nicotine is 'impact boosted' – it is converted into a form that is more rapidly absorbed in the lungs and hence in the brain and central nervous system.

To prevent Wigand from blowing the whistle, his former employer threatens him financially by promising that monthly payments will be cancelled and that prosecution for breaking a confidentiality agreement will be initiated. When these threats do not stop him from getting in contact with Lowell Bergman, a journalist at the CBS program '60 minutes' and former student of Herbert Marcuse, other kinds of harassment begin. Wigand is spied on, he receives threats on the lives of himself and his family, and lies about his past are leaked to the press.

As the story ends, the unscrupulous actions of Brown and Williamsson have been revealed to the public. But by that time Wigand has lost his job, his wife and children have left him, and his personal life has been scrutinised in public. Being a whistleblower is not without personal sacrifice!

Sometimes whistleblowers are sent to prison. This was the case for Mordecai Vanunu, after he revealed in 1986 Israel's atomic secret to the London-based newspaper *The Times*, and made it clear to everyone that Israel had joined the un-official nuclear club. After having been tricked to fly to Rome and subsequently abducted by MOSSAD agents, he received an 18-years sentence for espionage. On April 22nd 2004, Mordecai Vanunu was released from prison [83].

As mentioned earlier, scientific results produced at universities are entangled with social processes that support their reliability and validity. The situation is very different for knowledge produced and applied elsewhere, for example in private companies and military research institutions. Here Merton's ethos of science is not in service, as knowledge produced in private or military research laboratories is not necessarily made public, and therefore cannot always be tested systematically by the scientific community [84].

Not all scientists and engineers work under university-like conditions, where they would normally be allowed to freely publish their findings; furthermore, many scientists working in non-academic environments are not permitted to be completely transparent with regard to their (methodological) foundations. Hence, due to the lack of appropriate social structures, we cannot take for granted the trustworthy nature of the knowledge claims raised by 'non-transparent' sources – such as the research laboratory of a tobacco company or a governmental institution defending state policy – nor can we assume that we are always told the whole story.

Trust in knowledge claims posed by 'non-transparent' institutions, where the ethos of science is not a guiding principle, could be gained if an alternative social mechanism was set up to prevent such institutions from holding back vital information from the public, or distorting it before it is made public. Here I want to suggest that whistleblowing can constitute such a mechanism. The argument is that it will not be in the self-interest of 'non-transparent' institutions to act in unethical ways if they risk whistleblowers' disclosures.

For whistleblowing to become institutionalised as a social mechanism that minimises unethical behaviour in closed research settings, I think several conditions need to be fulfilled: First of all, the lives of whistleblowers must not be destroyed after blowing the whistle. Only few persons will do that if the most likely consequence is personal destruction. Harassment of whistleblowers could be minimised if laws were passed that explicitly protect whistleblowers.

In September 2003, the Association for the Promotion of Scientific Accountable Behaviour (APSAB) organised a conference where firstly the establishment was discussed of an international convention which would state that a 'conscience clause' must be included into the labour agreements between employers and worker representatives:

> The conscience clause entitles any scientist or engineer employed by any private or public organization and having duties or responsibilities in the field of science or technology to report to an independent body in the country in which the organization's headquarters or the headquarters of its parent company are located, [about] any and all activities undertaken in ongoing and deliberate breach of:
>
> - The precautionary principle;
> - Public health;
> - The environment;

- Ethical and professional codes regarding scientific research and technological production [85].

At the conference, representatives from scientific organisations, national bodies, international organisations, economic and industrial organisations, and labour organisations gave their view on the idea of a conscience clause. At APSAB's homepage all conference presentations are accessible in written form [86]. Secondly, an independent institution needs to be set up that can control the truthfulness of accusations raised by whistleblowers. The institution needs a team of trusted inspectors that have the power to investigate and evaluate whistleblowers' allegations. Thirdly, scientists and engineers must feel obliged to blow the whistle when they encounter wrongdoing. The seed to this feeling can be sowed in ethical training programs for science and engineering students. Hence I have now returned to the starting point of this article.

In this section I have introduced the concept of the 'whistleblower', and argued that social mechanisms need to be set up (i) to protect people who blow the whistle, and (ii) to help validate and support their claims. In closed research settings, the whistleblower idea reflects both academic and social responsibilities of scientists. A whistleblower does not only act in a socially responsible way. (S)he also actualises the academic responsibility within non-transparent research settings, as whistleblowing may increase the credibility of knowledge claims originating from closed research settings.

Conclusion

In this paper I have applied an analytical model of the relations between the ideal ethical values of science, science's social mechanisms and institutions, and individual responsibility of scientists and engineers to two cases, and thereby illustrated its usability. The first example concerns Merton's ethos of science, how it materialises in appropriate social mechanisms and institutions, and translates into academic responsibility. The second example looks at misuse of science, as it balances Hans Jonas' imperative of responsibility with international law and scientists' social responsibility.

I conclude that within the academic sphere scientists hold a responsibility to produce credible, transparent scientific knowledge that is not twisted by external interests. When producing academic scientific knowledge scientists are required to follow Merton's ethos of science. Usually the institutions of science insure that the ethos of science is followed, but in concrete situations scientists are responsible to reflect whether this is actually the case. Scientists also need to know the limits of the ethos of science, and to realise that it only applies in the context of justification.

When the techno-scientific development affects the environment, human health and our social settings, it needs to be governed by societal regulation mechanisms. Hence, techno-scientists are required to follow ethical principles, e.g. Kant and Jonas's moral imperatives – though their social responsibility also encompasses reflections on these guidelines. Furthermore, scientists and engineers are obliged to reflect on existing regulation mechanisms and institutions (such as national, regional and international law), and ask whether these mechanisms and institutions satisfactorily mirror ethical principles, or need to be sharpened.

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