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ETHICAL ASPECTS OF RESEARCH IN TECHNOSCIENCE

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Abstract

The paper contains an overview of ethical issues related to technoscience, followed by a more detailed presentation of ethical aspects of measurement-based experimentation, publishing peer-reviewing practices. The need for increased sensitivity of scientists to this kind of issues is justified by the evolution of research institutions in the postmodern era.

Keywords: research ethics, scientific misconduct.

1. Introduction

According to Charles Murray, ethics belongs, together with logic and scientific methods, to the greatest meta-inventions of humanity [1]. It is a philosophical discipline dealing with the moral principles and norms of human conduct. Not every type of human activity is the proper object of ethics since morality is concerned only with free conduct. More precisely, the object of ethics is determined by the scope of our moral responsibility: we are responsible only for the fully conscious, free and voluntary actions, and only if we know that they are good or bad. According to the traditional assumptions of individual ethics, we are responsible not only for the bad or good acts themselves, but also for their future consequences. This assumption is getting problematic in case of complex collective enterprises where those who initiate them lose control over their future developments. Such a situation is getting more and more characteristic of applied sciences where the researchers very quickly lose control over practical applications of their work results since the latter are quickly overtaken by research and development teams, and next – by business and marketing people [2]. When answering the question about ethical responsibility of today's scientists, one has to take into account the integration of traditional academic science and industrial science into a global hybrid institution, called technoscience, whose employees, including scientists, have to perform new roles – the institution in which ethical considerations can no longer be kept aside like they could be in the XIXth century [3]. Now, more and more frequently, practical applications of knowledge follow immediately its generation by researchers; a category of scientists involved exclusively in cognitive studies is quickly shrinking down. A distinctive feature of technoscience – in contrast to the technology of the industrial era – is the incorporation, not only application, of knowledge, and the universal application of scientific methods. A distinctive feature of technoscience – in contrast to the science of the previous century – is its enormous demand for the products (instrumentation, materials and software) and institutions of technology which are more and more frequently replacing traditional academic laboratories where the scientific theories are verified. [4]

The positivists postulated the axiological neutrality of science, but the historical experience of the XXth century clearly demonstrated that such an assumption can be very dangerous for

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our civilisation as a whole and for our science in particular. Already 40 years ago, German philosophers Karl-Otto Apel and Jürgen Habermas started the debate on ethical aspects of social communication, and showed that the objectivity of science requires a community of argumentation, and that argumentation may be meaningful only if it follows some ethical principles: the respect of truth, responsibility for information, and the respect for others [5].

There is increasing concern about ethical condition of the research community; it is expressed by many researchers, attorneys, and university administrators concluding that the scientific misconduct is getting epidemic [6]. More and more researchers are getting negligent and unwilling to acknowledge their mistakes; by their actions, the ability of the research community to govern itself is frequently called into question [7]. That is the main motivation behind this paper which contains an overview of ethical issues related to technoscientific research, followed by a more detailed presentation of ethical aspects of measurement-based experimentation, publishing and peer-reviewing practices. There is no scientific novelty in this paper; it is an essay-type compilation of the author's views and of the opinions of others, obviously consistent with the author's views. It is an extended and updated version of the author's paper presented at the 2010 Congress of Metrology in Łódź, Poland [8].

Ethics is, obviously, not a chapter of measurement science, neither a field of measurement technology. So, the reader may legitimately ask about the author's motivation for publishing such a paper in *Metrology and Measurement Systems* quarterly. In brief, it originates in the author's conviction that – with the advancement of science and technology in the postmodern society – the ethical problems are becoming more and more important. The author's experience – related to his academic service as professor and dean of the faculty, guest editor, reviewer of numerous journals and conference papers, evaluator of grant proposals, examiner of Ph.D. theses, and also chief scientific officer of a Canadian company – seems to prove that their solution is a *sine qua non* condition of the further progress in the contents and methodology of technoscience. One may even risk the statement that their solution is, in many situations, more critical than the theoretical and technical developments themselves. The growing incidence of research-related situations, provoking ethical concerns, seems to indicate the necessity to broaden a public discussion including, in particular, the measurement community.

2. Overview of ethical issues related to technoscientific research

2.1. Research as an information process

An information process is a sequence of operations or actions aimed at processing of information. The information, related to research activities, may be structured into several streams: a stream of scientific information, a stream of technical information, a stream of financial information, a stream of logistic information, and a stream of formal and legal information. Research-specific ethical issues are most closely related to the first two streams of information, but they should be considered in the context of other information streams. Both researchers themselves and those who, in various ways, benefit from the results of their work are interested only in true and useful information. The veracity of information is menaced both by some objective problems of epistemological or methodological nature, and by subjective problems of ethical nature. Similarly, the utility of information is endangered by objective problems of technical nature, and by subjective problems of ethical nature. Ethical issues, specific of research information processes, are related to:

– the acquisition of the input information, *e.g.* a theft of information or an infringement of personal goods (dignity, health, life);
– the processing of information, *e.g.* fabrication or falsification of intermediate information

Metrol. Meas. Syst., Vol. XVII (2010), No. 4, pp. 00–00

or insufficient diligence in the implementation of procedures of information processing;
- the transfer of output information, *e.g.* marketing of research results during scientific conferences, an "honorary" authorship of publications, a transfer of immature research results to the stage of their implementation.

2.2. Scientific misconduct

The unpopularity of truth, accompanying the transition from modern to postmodern culture, is implying the loss of confidence in reason and science. This is a paradox of our times that the rapid development of technoscience is accompanied by decreasing interest of the societies in science and their increasing distrust in its achievements. This phenomenon, together with the progressing specialization of science, has enabled centres of political power to overtake control in science; those centres are not – as a rule – interested in the truth aspect of science but in its practical applicability... But truth is the central value of science. Any scientific misconduct has its roots in a transgression against truth. There is no unique definition of scientific misconduct, but all proposed formulations include [9], [7]:
- fabrication, *i.e.* making up data or other significant information in proposing, conducting, or reporting a research project;
- falsification, *i.e.* changing or misrepresenting data or other significant information such as the investigator's qualifications and credentials;
- plagiarism, *i.e.* representing the work or ideas of another person as one's own.

Sometimes, "other serious deviations" are included in the definition of scientific misconduct, such as theft of data, damage to research equipment, sabotage of experiments, misuse of funds or gross negligence in professional activities. Funding agencies explicitly include, in their definitions of misconduct, deception in proposing a research project [7], [10]. The cover-ups of misconduct in science, malicious allegations of misconduct in science, and violations of due process in handling complaints of misconduct in science are also considered to be instances of misconduct [11].

Questionable behavior of scientists is not a new phenomenon; it was a subject of concern already in the first half of the XIXth century when Charles Babbage, known mainly as the author of the concept of a programmable computer, wrote a book about the lack of honesty in British science [12]. In the second half of the XIXth century, Louis Pasteur got famous for his pioneering works leading to the development of vaccines for anthrax and rabies, in particular after a spectacular inoculation trial on sheep. An examination of his data books revealed that the anthrax vaccine used in that trial was prepared by a chemical inactivation method developed by his competitor, Jean J. H. Toussaint, while publicly Pasteur claimed that he employed his own method. [13] Questionable behaviour of such prominent researchers as Robert Millikan or Gregor Mendel, has been discussed up to now in the literature concerning fraud and misconduct in science [14]. After World War II, when the world learned (during the Nuremberg trials) about the horrors of Nazi research on human beings, both scientists and politicians became aware of the urgent need for ethical reflection on research; such physicists as Albert Einstein and Robert Oppenheimer, supporters of research on atomic weapons during the war, started to advocate for the peaceful use of atomic energy after the war [15].

A qualitatively new situation was created in the late 1970s by the news media which extensively covered a number of cases of alleged misconduct prosecuted publicly. Then the process of the articulation of definitions and rules about scientific misconduct – accelerated in the 1990s – was initiated in USA by the federal institutions providing research funds, and undertaken also outside USA. At the same time, courses on research ethics were introduced in graduate curricula at many universities [13]. Since then numerous flagrant examples of research and academic misconduct have been reported in details, including the names of culprits, in the relevant literature [15], [16–27], also in the Polish literature [28–40]. Both general public and scientific communities have been shocked in recent years by an increasing number of cases of fraud committed by scientists [10]. What are the causes of this phenomenon inside the structure of the institution called science? The answer given by Gottfried Schatz seems to get to the point: "*… we scientists are also contributing to the mess. We want to be smart and forget to be warm. We think too much about competition, and not enough about generosity. We go for power, and forget that power and science don't mix. We are so anxious to become famous that we have no time to think about what science is all about. There are too many congresses, committees, evaluations, prizes, honours, and elections to academies. There is just too much noise.*" [41].

During the last 30 years, the evolution of research ethics has followed the lines drawn by Karl R. Popper: from the traditional ethics, based on the idea of individual authority and certain knowledge, towards a new ethics, based on the idea of collective authority and uncertain knowledge (in both cases, the term "authority" is used in the sense of "epistemic authority" as meant by Józef M. Bocheński [42]). The most significant change is related to the problem of cognitive errors. In the past they were excluded from consideration while the new ethics has acknowledged their omnipresence [43]:

– The quantity of knowledge, even knowledge accumulated within a single specialty, is too vast to be mastered and controlled by a single person.
– It is impossible to avoid all the errors, even those that potentially can be avoided; they may appear even in the most established and verified theories.
– Tracing the errors is an important task and duty of the researchers; they should be, therefore, open to them, should look for them, analyze them, and learn from them.
– Self-criticism and gratitude for external criticism is thus their moral obligation.
– *Ergo*, organized methods and mechanisms of criticism are a systemic necessity of science.

2.3. Factory of knowledge

Today good science is assumed to be, especially by governmental and financial institutions, an applied science generating immediate income. There is an overwhelming tendency to apply the free-market paradigms to technoscience. It means, in many cases, that somebody – who is going to be paid for a scientific or engineering idea – may be tempted to sell it at the highest possible price, regardless whether it is true or not, whether it may be used against human beings or not, whether it is one's fully original idea or not. The fabrication of data for a grant proposal is a form of scientific misconduct which is getting epidemic under such circumstances: usually, the author of such proposal has some scientific evidence for a conclusion, but he/she seeks to exaggerate the strength of that evidence [7]. This kind of misconduct seems to be particularly frequent in biomedical sciences [41]. Another major concern related to the market rules of funding research is a potential conflict of interest in the review of manuscripts and grant proposals, since a positive opinion may mean helping the competition.

The scarcity of research funds and competitive atmosphere among scientists discourage scientific openness and cooperation which belong – together with universalism, disinterestedness and organised scepticism – to the traditional (Mertonian) norms of science [44]. Scientists are hunting for free data and information to put into their proposals, while at the same time withholding information about their own accomplishments. Scientific meetings have turned into "diplomatic" discussions of where the money is and how it can be accessed. Many researchers are spending more time on writing proposals than on research itself. Gottfried Schatz seems to get the point again when saying: "*Today's science is too much dominated by efficient people with cold eyes.*" [41]. They are intelligent enough to quickly

Metrol. Meas. Syst., Vol. XVII (2010), No. 4, pp. 00–00

learn how to effectively approach granting institutions, how to choose the research subject to warrant a positive outcome, how to approach scientific gurus to get a positive evaluation, a review or a recommendation. They know the rules of the game, and apply them in practice in a scrupleless way [45].

The climate of the "factory of knowledge", dominating over contemporary science, is discouraging the researchers to pursue the truth. They have to adapt, *i.e.* to become efficient in the above-described sense, in order to survive in the institution [45]. Productive scientists complain that they are plagued with administrative work and committees, by the paperwork required by granting agencies and foundations, *etc.*; they complain, but have no choice … This is an additional risk factor of scientific misconduct: in many recently reported cases, the culprits were under career pressure or thought they knew what the answer would turn out to be if they completed the research work properly [46]. Being overtired or in a rush to meet a deadline are often given as explanations for negligence in performing tasks or fulfilling responsibilities, for departures from good research practice – euphemistically called "cutting corners". The pressure to prove the value of one's work by publishing is a common element in many cases of reckless research [7].

3. Ethical aspects of measurement-based experimentation

Measurement is a source of evidence in technoscience. The ethical misconduct related to the methodology of measurement, to the execution of measurements or to the interpretation of measurement results may have, therefore, a significant negative impact on the quality of technoscientific research. By working with incorrect or unsubstantiated measurement data provided by others, one may corrupt one's own research, regardless of whether the data have been distorted intentionally or not [9]. Many prominent cases of pathological science are rooted in data manipulation – intentional or not – but always grossly misleading [47]. Enough to say that, according to a 2006 German inquiry, 90 % of studies made in or for the pharmaceutical industry have been in various ways manipulated [48].

Measurement is an operation aimed at acquiring information. Measurement science and technology is thus a part of a broad super-discipline called information technology. Ethical problems, characteristic of information technology in general, apply – at least partially – to measurement-dependent research and practice. The ethics of information technology is including computer ethics (which traditionally deals with problems of privacy, accuracy, intellectual property and access, security and reliability), but it is not limited to the latter [49], [50]. Information technology, by transforming in a profound way the context in which traditional ethical issues arise, adds new dimensions to old problems [51]. Global networking of societies implies depersonalization of communication and increased sense of anonymity. The diffusion of responsibility brings with it a diminished ethical sense in the agent and a corresponding lack of perceived accountability. On the other hand, qualitatively new phenomena, related to infosphere, encourage the formulation of new ethical requirements concerning the management of entropy in the infosphere and the promotion of information welfare by extending, improving and enriching the infosphere. Infoecoloogy is the name of this emerging branch of ethics.

3.1. Measurement methodology

Today, most philosophers of science agree that science is unable to prove the veracity of some basic assumptions (paradigms) it has been for centuries based upon. We know since 1931, when Kurt Gödel published his incompleteness theorems, that even mathematics is unable to prove that some its statements are true or false. It is, thus, not surprising that measurement science is unable to prove that the results of measurement contain any truth about physical reality; the discourse between realists and instrumentalists is, therefore, continued [52]. Methodological relativism, inspired by this situation, implies sometimes ethical permissiveness in studying and doing measurements, the permissiveness being a source of serious ethical concerns. To minimize the ethical risk, the measurement people have to be extremely clear about the methods they use to gather and process data; they should be aware that not only the validity of the data but also the validity and precision of the procedures used for acquisition of those data are subject to evaluation. The uncertainty of measurement results may imply the uncertainty of the decisions or actions based on those results. This becomes a sensitive ethical issue if those decisions or actions touch welfare or lives of human beings. Taking into account that the cost of measurement is usually growing exponentially with the required accuracy, one may be tempted to replace more accurate data with less accurate data, one may be tempted to underestimate measurement uncertainty for publication purposes.

3.2. Acquisition and processing of measurement data

Fabrication and falsification of measurement data are two major forms of misconduct in technoscientific sciences. Several factors seem to encourage researchers to publish false data: academic researchers are under pressure of the syndrome “publish or perish”; prominent scientists may be tempted to “cut corners” because they feel that nobody will challenge their results; busy peer reviewers may be inclined to scrutinize papers only for obvious flaws [21]. Selecting data, to support one’s hypothesis, means also their falsification if it is not based on some intersubjectively agreed methodologies (called elimination of outliers).

The uncertainty of measurement data should be assessed and disclosed to make those data meaningful. However, sometimes the quantitative expression of measurement uncertainty is impossible. This applies, in particular, to complex experiments of partially qualitative nature. In such cases, everything that might make the experiment invalid should be reported – not only what one thinks is right about it: other causes that could possibly explain the results, factors whose influence has been eliminated by some other experiments, *etc.* In contrast to advertising, one should give all the information to help others to judge the value of one’s contribution – not just the information that leads to judgement in one particular direction or another [53].

The validity of procedures, used for acquiring the data, is a primary responsibility of measurement people. Today, it should be complemented with the secondary responsibility for the interpretation of those data, *viz.* for the validity of a procedure of inference underlying this interpretation, because – since the advent of computerized techniques of measurement – it is getting to be, more and more, an integral part of the measurement process. A researcher presenting experimental results is responsible for the procedures applied for acquisition and interpretation of measurement data even if he/she has borrowed them from a software library. Despite expectations, the availability of such libraries is today one of the major causes of growing ignorance about statistical methods for processing measurement data, and of growing incidence of intended or unintended misuse of those methods [54].

4. Ethical aspects of publishing

A reader of a scientific paper may agree or disagree with its conclusions, but he/she wants to trust the account of procedures that were used for obtaining the results underlying those conclusions [46]. Thus, the deliberate presentation of a conclusion as true, when its author knows it to be false, is a cardinal instance of scientific misconduct related to publishing

Metrol. Meas. Syst., Vol. XVII (2010), No. 4, pp. 00–00

research results. Much more frequent, however, is the exaggeration of what the researcher has done or of the strength of the evidence for the presented conclusions.

Like falsification, plagiarism is a fundamental betrayal of trust. Plagiarism fails to credit another's contribution. Credit may be given in three different ways, appropriate in different circumstances: inclusion as an author of the article, listing of one's contribution to the work in a formal acknowledgment or citation of a corresponding work [11]. An author should cite those publications that have been influential in determining the nature of the reported work and that will guide the reader quickly to the earlier works that are essential for understanding of the reported investigation. An author is obliged to perform a literature search to find, and then cite, the original publications that describe closely related works [7]. Citations not only acknowledge the work of other scientists, but also indicate conflicts with other results, and provide support for the views expressed in the paper; thus, citations place a paper within its scientific context – relate it to the present state of scientific knowledge [11].

The attribution of undeserved credit qualifies also as scientific misconduct. Quite frequently, the name of a person is included in a list of authors even though that person had very little or nothing to do with the contents of a paper. Such practices depreciate the credit due the people who actually did the work, while inflating the credentials of "parasites". A.E. Shamoo and D.B. Resnik have identified four types of related abuse, *viz.* gift authorship, honorary authorship, prestige authorship, and ghost authorship [15]. In the first case, the inclusion of a person in the list of authors is a personal or professional favor, in the second – a sign of respect or gratitude. In the case of prestige authorship, a person with a high degree of prestige or notoriety is listed as an author in order to give the publication more visibility or impact; in case of the ghost authorship, the name of a person who wrote a manuscript does not appear – for various reasons – on the list of its authors.

Many scientific journals now state that a person should be listed as the author of a paper only if that person made a direct and substantial contribution to the paper. According to the highest ethical standards, one should withdraw one's name from the list of authors if one does not agree with all the statements of the paper or does not consider the subject of the paper significant enough to be published. Strict observance of this rule would considerably reduce the quantity of scientific banality [45]. One of the mechanisms generating the number of insignificant papers is fragmentation of research results. It increased when the number of publications started to be an important criterion for funds allocation and academic promotion [7].

The banality, and sometimes lack of veracity, is effectively hidden in numerous papers behind a fence of oversophisticated or euphemistic language. Other forms of publication-related misconduct are the following: excessive redundancy, verbosity and lengthiness; "strategic" fragmentation of published research results; eristic tricks or intentionally introduced fallacious arguments. The most frequently-met logical misconstructions of the latter type are the following:

- excluded middle (assuming that there are only two alternatives when in fact there are more);
- appeal to anonymous authority (*"experts agree that..."*, *"scientists say..."*);
- false causation (assuming that because two things happened in a sequence, the first caused the second);
- confused correlation and causation;
- causal reductionism (trying to use one cause to explain something, when in fact it had several causes);
- selective observation (the enumeration of favourable circumstances and forgetting others);
- *non sequitur* argumentation (something that just does not follow);
- ambiguous assertion (a statement sufficiently unclear to leave some sort of leeway).

A journal space is a precious resource created at considerable cost; an author, therefore, has an obligation to use it economically. Ruthless use of the publishing privilege wastes the time of reviewers and editors [7].

After publication, scientists expect that data and other research materials will be shared with qualified colleagues upon request. A scientist who is unwilling to positively respond to this expectation runs the risk of not being trusted or respected. It has become a standard of journals in natural (including biomedical) sciences that potential authors are required to sign statements about their readiness to share research materials (including cell lines, micro-organisms, mutants, antibodies and reagents). Those materials should be available in reasonable quantities for non-commercial purposes only, not necessarily free of charge (at the cost of preparation and shipment) [55].

5. Ethical aspects of reviewing

Reviewing is the key method for intersubjective verification of research results; it is applied to publications (papers, books), degree projects and theses (at the B.Sc., M.Sc., Ph.D. and D.Sc. levels), as well as to applications concerning research grants, employment, promotion, awards, *etc.* A reviewer is directly responsible for the quality of an opinion, not for the decision made on the basis of this opinion, but indirectly – for the quality of publications, degrees, *etc.* – thus, for the quality of research output. A reviewer, like a judge, should be competent, independent and impartial, just and honest. An expert should not accept the role of a reviewer if he/she is lacking sufficient knowledge and experience in the subject concerned, or if he/she is related to the research subject or researcher concerned in a way that may engender a conflict of interest, or if he/she is lacking time or tools of reviewing. An expert should not decline the role of a reviewer if he/she has rare qualifications in the subject concerned; or he/she may suspect an instance of possible misconduct related to the object of review. The most widespread forms of misconduct, related to reviewing, are the following:

– plagiarism of concepts, ideas, solutions, *etc.*;
– unjust and/or unjustified and/or non-informative opinions;
– opinions lacking critical substance.

The growing number of positive or very positive, but blatantly superficial, reviews of doctoral theses is a product of various factors, such as: laziness combined with lack of responsibility, lack of competence, willingness to “help” an institution to deal with a shortage of academic staff, fear of being accused of low motivations, fear of being ostracized, flattery, and manifestation of magnanimity [56].

In case of an editorial process, the peer review has two principal aims: it should to help the editor make a good decision on the acceptability of the manuscript, and to help the authors communicate their research results accurately and effectively. Thus, a peer reviewer does not have to be an adversary of the authors; he/she should rather take a positive attitude toward them and their work, to avoid confrontational statements as well as impolite language. A lot of precious time is often wasted when authors feel the need to respond in kind to offensive language in their rebuttal letters to editors [55].

In case of evaluation of grant proposals, the reviewers and evaluators can gain unfair “insider information” about the mode of operation and priorities of funding agencies, and consequently about how to write convincing applications. In science, those with insider information – unlike employees of financial institutions – are not punished, but are free to use it and gain greater chances for being financed [15]. Another major concern related to the evaluation of grant proposals is a potential conflict of interest. Reviewers are advised to be sensitive to such a possibility, and – if in doubt – to return the proposal because of the potential conflict of interest, or – alternatively – to furnish a signed review stating the

Metrol. Meas. Syst., Vol. XVII (2010), No. 4, pp. 00–00

reviewer's interest in the work [7]. The reviewers of grant proposals, submitted to funding agencies, learn about others' ideas before they have been published. The related abuse consists in plagiarism of ideas, and occasionally of formulas or figures. To make the theft from a reviewed grant proposal effective, the reviewer assigns to this proposal a score sufficiently low to exclude its funding. The plagiarism committed by a grant reviewer is then a double offence: theft of intellectual property and unfair evaluation [11].

The institution of peer review – closely related both to publishing research results and to the mechanisms of funding research – is menaced by the recent evolution of the institutions of science. A referee, usually one of the few experts in the field, has an obvious conflict of interest. It requires very high ethical standards to not use anonymity for one's own advantage. Unfortunately, as time goes on, more and more referees abandon ethical standards after receiving unfair reviews when they are authors [46]. Another related problem is simple dereliction of duty by reviewers who "have no time" to read and carefully evaluate the work of other researchers. According to James R. Wilson, *"the problem of non-performance by referees has reached epidemic proportions, and (…) it is urgently necessary for the scientific community to address this scandalous state of affairs"* [47]. Peer review is thus one among many examples of practices that were well suited to the time of exponential growth of science, but are becoming today increasingly dysfunctional. We are currently witnessing the death of scientific criticism. Its main causes are the following:

– The contributions in this domain are not taken into account in evaluation procedures related to promotion of researchers and financing research projects.
– For ideological reasons intellectual competition in science is replaced by economic competition.
– The most effective strategies of survival in science are based on skillful combination of competition-type and cooperation-type behaviours.
– The consecutive generations of researchers are less and less aware of the methodological background of their professional activity and less and less skillful if the precise use of the language of science.

6. Conclusions

It has been already indicated in this paper that diverse ethical concerns of scientists, in particular those involved in measurement activities, are by-products of our modern civilization or gain importance due to the evolution of this civilisation. Global industrialization and the phenomenon of consumer society are two principal mechanisms that produce forces destructive with respect to the traditional systems of values, in particular to trust. The historical success of Western science has been built on a foundation of trust: trust that the results reported by others are valid and trust that the source of novel ideas will be appropriately acknowledged in the scientific literature. To maintain this trust today, much more attention must be paid by the scientific community to the mechanisms that sustain and transmit the values that are associated with ethical scientific conduct [57]. Numerous initiatives have recently appeared in various academic and professional milieus to counteract negative tendencies in the evolution of institutions of science. In particular, the courses on professional ethics have been introduced into academic curricula and codes of professional ethics have been issued by the research institutions and professional societies.

Numerous examples of courses of ethics for students of engineering may be found in the proceedings of annual conferences of the American Society for Engineering Education, published in 1995–2010 [58]. Those courses are usually aimed at increasing ethical sensitivity of students, by providing them with knowledge of relevant standards of conduct and enhancing their capacity of ethical judgment [59].

Numerous codes of professional ethics, issued by learned societies and professional associations – the codes differing in the literary form and the level of generality – may be found in the internet [60–65]. Unfortunately, the eruption of professional codes of ethics is often resulting from the lack of understanding of the fundamental difference between ethics and law. In modern societies, law is imposed and executed by political authority; it is codified, and it applies to strictly predefined issues, not necessarily concerning morality. Ethics provides a set of moral standards freely accepted by a person or a social group; it is a product of free, individual or collective, reflection over the dialectics of good and bad aspects of all human relations; it applies to both recurrent and completely new situations that are not morally neutral. The professional codes of ethics seem to imitate law. Consequently, they can be used as a tool for avoiding moral considerations. In some cases, they are designed merely to avoid outside regulation of a profession [66]. Even blind devotion to ethical codes cannot enable us to adequately respond to the ethical concerns of scientific vocation; the final burden is always upon our conscience and values. Genuine ethical autonomy is the product of reflective and honest choices taking into account the complexities that ethical dilemmas impose. The researcher's sense of identity and ethical responsibility demands critical reflection upon the multiple avenues of professional conduct rather than blind adherence to codes. This ability should be developed at home, at school, and at academe; it should be enhanced by positive examples of public life and creations of art; it should be practised in every-day life. Unfortunately, this list of wishful thoughts is very likely to be mocked by the some of the so-called moral authorities of our times...

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Metrol. Meas. Syst., Vol. XVII (2010), No. 4, pp. 00–00

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