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RESPONSIBILITIES OF SCIENTISTS IN A WORLD IN TRANSITION

Abstract: More than ever our societies as well as their individual members are in motion to-day. To a great extend science is accessary to these transitions, in part by extensively growing itself and creating an ever increasing array of technological applications. The relevance and salutary effects of science are unquestionable. At the same time, however, in many writings and discussions in the public media the classical reverence of science and the public admiration of its achievements have been replaced by doubts, scepticism, distrust and sometimes even enmity.

Much of this negativism is unwarranted, but there are also honest concerns. Not always have scientists and engineers been able to keep the developments in science and social and ethical constraints in proper balance. The paper will identify a number of grounds for no-go or slow-go decisions.

Moreover, in many areas, and notably in biotechnology, the classical problem of 'dual use' has become a basis for serious concern. Medicine and health have benefitted enormously from the developments in pharmacological and biomedical research. At the same time these developments can be harmful if being misused by evil regimes or terrorists. The recent H5N1 avian flu research is a case in point, and can serve as a test case in the discussion on the conflict between freedom of inquiry and publication on the one hand and the obligation to prevent harm to individuals and society on the other. This paper makes a plea for a balanced approach.

Key words: *Criticism of science, Responsibility of scientists, Dual use, Biosecurity*

1. PANTA RHEI

The theme of this conference is very well chosen. More than ever our societies are in motion to-day: from traditional to liberal, from local to global, from constituted to revolutionary, from predicable to uncertain. Our scientific models, traditionally so useful for understanding and action, too often fail us nowadays in providing proper insight and allowing accurate predictions. The embarrassing experi-

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ences in the financial crisis, the contention in the debate on global change and climate control, the controversial distortions of the balance between fear of terrorism and protection of citizen's privacy, the disagreements on limits to be set to the application of ever more advancing and costly medical treatments not only on economic but also on human grounds … these are all cases in point.

Needless to say that Herakleitos' seemingly valid *panta rhei* applies equally at the individual level. Throughout history major societal or cultural changes have always had an unavoidable influence on individual lives and families. The transition first from a nomadic/hunting to an agricultural, and then from an agricultural to an industrial society, delineated as the first and second wave by Alvin Toffler[1], both gave rise to conspicuous changes for the individual and in family life of the members of the tribe or society. And how perceptive was Toffler's prediction three decades ago that a new society and civilisation was to be expected as resulting from the third wave that he described, the information revolution, influencing our life styles, our learning, our work roles, our social, economic and political structures, and even our opinions, attitudes and moral judgements.

Nowadays we are under the spell of information indeed. Information has become the key to influence and power. The World Wide Web, originally developed at CERN in 1989 by the British physicist Tom Berners-Lee to meet the demand for automatic information-sharing between scientists in universities and research institutes around the world, has grown to revolutionize communications worldwide. Direct applications in the form of social media provide opportunities to create, share and exchange information in virtual communities, bringing about substantial changes in communication between individuals, organizations and communities. In the meantime these social media (Face book, Twitter, LinkedIn, YouTube and others) govern a good deal of the lives of the citizens of modern societies and their children. In the USA, time spent on social media increased from 88 billion minutes in 2011 with almost 40% to 121 billion minutes in 2012[2]. The impact of social media is hard to over-estimate: the reach, frequency, immediacy and permanence of these new media are many times higher than those of the classical means of communication.

However, as often with fast technology-driven changes, this development has both blessings and drawbacks. Next to the benefits for communication, entertainment, education, mobilization (e. g. teh Arab Spring), greater transparency and commercial applications we see also lack of control, invasion of privacy, cyber bullying, sexual abuse, and a decrease of face-to-face interactions. Social media expose children to drinking, smoking, and sexual behaviours that many would consider harmful. Not everybody, and certainly not every government, applauds the activities of Julian Assange, who launched his WikiLeaks in 2007 as a secure and anonymous way for sources to leak information to journalists, or those of Edward Snowdon, the

[1] A. Toffler (1981), *The Third Wave*. London: Pan Books.
[2] Mentioned in Wikipedia *Social Media*.

former employee of the CIA, who whistled to the media the large scale tapping of telephone conversations and e-mail communications of friend and foe.

2. PANTA RHEI IN SCIENCE?

In this discussion the question of the role of science forces itself upon us. Is science accessary to this development? Or even: Is science subject to the same transmutations as society in general?

There is no doubt that science carries substantial complicity in the mutations indicated above. Science and its practical translation in technology systems have laid the basis for many developments, inventions, measures or treatments that have radically changed our lives. Science has also substantially improved and changed our insights in how the universe, nature, social institutions and human beings function, leading to many an adaptation of the environmental or societal infrastructure in which we operate.

To give an example from my own academic field, cognitive and neuro-psychology: Recent technological developments have vastly enlarged and changed our insight in how the human brain works and effects behavioural and cognitive operations. In the past brain scientists could only remove the brain of patients after their death and try to relate the disease to a location in the brain. Then came *radiography*, for which Röntgen received the Nobel Prize in 1901. With X-rays we could obtain images, but only of hard matter (bone tissue). In the third phase it became possible to see 'wet' tissues by combining X-ray systems with other sensors, and using computer programmes for the analysis, the so-called '*computer tomography*' or CT, a discovery for which Hounsfield and McCormack received the Nobel Prize in 1979. In 2003 Lauterbur and Mansfield received the Nobel Prize for a further development, the invention of *Magnetic Resonance Imaging* (MRI). What happens is that by creating a very strong magnetic field the protons (and therefore the nuclei) of the hydrogen atoms in the water molecules are magnetizised. The results, however, differ for various tissues (white matter, grey matter, skin, blood vessels and others). Through this imaging we can observe the brain in great detail. Through measurement at different times we can see how it grows, how it changes with learning, throughout exercise, etc. A real improvement of MRI was offered by Seiji Ogawa and his colleagues by the application of *functional MRI* (fMRI). Based upon the old insight that an increased blood flow occurs in those regions of the brain that are active and create an enlarged energy demand, fMRI registers changes in the blood flow, and can thus produce images of the working brain. Denis le Bihan's refinement of fMRI by inventing *diffusion fMRI* even bypasses the sometimes too slow registration of regular functional fMRI and increases the exact coding of neuronal activity[3].

[3] D. le Bihan 2012), *Ecotechnology of the water molecule in the human brain.* Lecture at 33 d Honda Prize Award Ceremony, 19–11–2012, Tokyo.

Similar augmentations of knowledge and evolvements of methods of analysis can be observed in a great many other fields of science. I have just depicted the developments in the area of brain and behaviour as an example of the revolutionary evolution of our understanding of the neuro-scientific bases for our perceptual, cognitive and emotional behaviour. Likewise, most scientific insights continuously amplify, grow, change, and scientific theories are constantly being refined, adapted, replaced if necessary. That is the very nature of dynamic science. And there is no doubt that these developments in science and technology seriously contribute to the sometimes staggering changes that take place in the world we live in.

Quite another question is, of course, whether scientific truths and principles themselves are also subject to this change process and are time – and culture bound or whether we can presume stability and universality of the conceptual and analytical principles in science. Universality of science has not always and everywhere been accepted. For instance, in Christian orthodox circles the view was defended that Christian science should be of a different nature than non-Christian science. In 1880 Abraham Kuyper, the founder of my own university, the VU University Amsterdam, resisted the at the time dominant positivistic universalism of science and defended that Christian science needs to be more than the practise of science by Christians: "It is a science that qua principle, method and result is really Christian, i. e. leads to the knowledge and acceptance of the only true God and Jesus Christ". Nowadays we still see, as I wrote recently[4], the same anti-universalistic (basically: anti-western) attitude with respect to science in the Muslim world. Many ulamas (Muslim religious scholars) require science in their countries to become Islamised and to be subservient to the Qur'an. They proclaim contemporary science to be Western and, consequently, rejectable. Of course there are enlightened Muslim scientists and scholars (Hoodbhoy, Abdus Salam, Serageldin, Bradran, Zou'bi, Guessoum, Al-Azm) who vigorously oppose the claim of 'otherness' of Muslim experience and reject the notion that they should develop an 'Islamic' science. They adhere to the universal scientific norms of honesty, freedom of thought, freedom of speech, the use of critical reason, empirical validation of hypotheses, and tolerance for diverging views. However, given the popularity of fundamentalist views (see for instance the many anti-Western internet sites) and the persistent dominance of religious dogmas in educational Muslim circles not only in Middle East and Asian countries but also in the West (Thomson[5]) these may as yet be voices in the wilderness, although they bear fruits of hope.

Omnia mutantur therefore, but not the laws and principia of the empirical sciences. The principles of critical reasoning, testing of ideas and hypotheses on the

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[4] P. J. D. Drenth (2013), Trust in science, but keep your powder dry. In:. Hermerén, K. Sahlin & N. E. Sahlin, *Trust and Confidence in Scientific Research*. Stockholm: KVHAA.

For a more elaborate discussion see P. J. D. Drenth (2013), Bridging political, cultural and religious divides; the role of Academies and Humanities. *Eruditio; the E-journal of the World Academy of Art & Science,* 2, Febr. 2013, 1/8–8/8.

[5] D. Thomson (2008), *Counterknowledge,* London: Atlantic Books.

basis of facts and observations, and validity of confirmed theories are universal and permanent as brought to light in the Enlightenment. They applies even to the empirical social and behavioural sciences that deal with phenomena that are pre-eminently changing and culture-bound (human behaviour and social structures). As I stated before[6] "the cultural specificity can only be understood against the background of communality and universality of theories and methods and not vice versa. Insights that have been acquired through subjective and culturally contextualised methods always have to be verified or falsified with methods independent of the subjectivity of the observer in order to achieve a scientific character. Science requires objectivity and independence" (p. 115–116).

3. SCIENCE: BENEFIT OR RISK?

Not many people will question the relevance and salutary effects of science. Of course the definition of relevance may differ depending on one's point of view. For the leftist politician it is the extent to which science contributes to the emancipation of the lower classes and to the furthering of a free and democratic society – for the health care expert it is the extent to which science produces medical knowledge and treatments through which average life expectancy increases – for the economist it is the degree to which sciences conduce to industrial and economic growth – for the philosopher it is the extent to which scientific and scholarly research lead to augmentation of the body of knowledge, which they see as an intrinsically valuable and precious quality of civilisation. And science has tried to meet these different objectives and expectations, in many different ways. It has contributed considerably to health and welfare, to comfort and convenience, to moral and intellectual elevation, to democratization and autonomy, to understanding and tolerance, to economic growth…

Given these beneficial effects, why do we notice a clear decline in the public appreciation of science? Why is it that nowadays the almost matter-of-course appreciation and reverence is replaced by scepticism, suspicion and sometimes even plain enmity? A number of years ago the Eurobarometer[7] reported not only the disturbing finding that European citizens, and in particular women, elder people and lower educated people, consider themselves poorly informed about science and technology developments, but also that people have reservations and even fear of science and scientists. Their high degree of knowledge could make them too powerful and concern was expressed that they may not always refrain from crossing ethical boundaries. At the same time there was, paradoxically, the expectation that primarily thanks to the contribution of science and technology disasters could be avoided and that present and future life could be ameliorated.

Why this criticism and these anti-science attitudes?

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[6] P. J. D. Drenth (2004), The universality of scientific values. In: L. C. Christophorou & G. Contopoulos (eds), *Universal Values.* Athens: Academy of Athens, pp. 111–121.

[7] Eurobarometer Reports (2005), Brussels, EC.

A number of factors and circumstances can be put forward as possible reasons:

- We mentioned already the curtailment of free science by orthodox religious pressures. We all know the historical examples of Galileo, Spinoza, Diderot… But we also witness the still existing Christian orthodox refusal to accept evidence from the study of evolution or the Muslim rejection of 'Western' science all together.
- Quite a few people entertain the, unfortunately not always unreasonable, fear of mischievous (often unintended) effects or products of science: air pollution, environmental deprivation, contagious viruses, mass invasion of privacy, genetic deformations…
- Then there is the alarming 'march of unreason' (the title of the book of Taverne[8]). Many people develop an unfortunate aversion to rational and coherent thinking and to scientific and logical argumentation, which takes time and effort, and prefer to think in the intuitive mode, which is swift, associative and effortless. This differentiation bears resemblance to Kahneman's[9] distinction between System 1 and System 2 thinking.
- The increasing scepticism is also fed by an unfortunately not declining public interest in pseudo-scientific phenomena and 'theories', such as UFO's, aliens and extra-terrestrials, astrology, psychokinesis, telepathy, reincarnation, homeopathy, corn-circle makers and voices of the dead. Newspapers and other media easily pick up these themes and contribute to the dissemination of this bogus fads, fallacies and fashions by sensational stories and suggestive illustrations.

But it would be injudicious to label all criticisms of science and scientists as inappropriate and objectionable. Some of the captious questions posed to science are certainly amendable to reason, and some of the negative attitudes are prompted by honest concerns. Is *homo sciens* capable of handling the power that used to rest in divine hands, but which is now at his own discretion? Is he always sufficiently aware of the moral implications of his scientific discoveries?

4. QUESTIONS OF RESPONSIBILITY

It is clear that the scientific enterprise is embedded in a social/ethical context that is becoming more transparent and publically discussed nowadays. Pressing questions of responsibility are imposed on present-day scientists. And if they do not pay serious attention to these meta-scientific questions these may eventually erode the axiomatic quality of science and even pose a threat to science as an intellectual endeavour. These questions include:

- The issue of justifiability of the choice of a research topic; is it worth knowing what we will learn from our investigation?

[8] D. Taverne (2005), *The march of unreason*. Oxford: Oxford University Press.
[9] D. Kahneman (2011), *Thinking, fast and slow.* New York; Farrar, Straus and Giroux.

- Are there 'no-go' areas for scientific research? Of course, freedom of research is a great asset, but research can inflict unacceptable damage upon the object of research, be it a human being, an animal, nature or culture. The nature or consequences of research could also be in conflict with universal human values, such as respect for human rights, protection of human dignity, and the safeguarding of equality and non-discrimination.
- Could it be that some scientific and technological developments, for instance in the medical field, are so fast and overpowering that the necessary ethical reflections on their impact and consequences cannot keep pace? Is it advisable to temporarily suspend such research until the ethical implications have been subjected to public discussion?
- Is the research sufficiently independent and free of external pressure and influences? Especially in view of the fast growing fraction of sponsored or contracted research this is a very probing question (see also the fear expressed by the former Harvard University President Derek Bok[10] that the intrusion of the market place into the university is eroding fundamental academic values).
- Does the researcher sufficiently observe the rules for responsible research procedures? One may think of the handling of all research subjects (humans, animals, culture, environment) with respect and care, with sensitivity to age, gender, culture, religion, or social class, the proper observation of human subject protocols, outweighing harm or distress to be inflicted upon animals by realistic expected benefits, and others[11].
- Probably the most pertinent question in this discussion is closely tied to the question of application and use of the research results. Research results can turn into blessings for individuals or the society, but they can also be badly misused by industry, governments or even other practitioners or colleagues, but also by evil nations and terrorists. How far does the responsibility of the researcher extend in case of immoral application and abuse? Let us discuss this issue under the heading 'dual use'.

5. DUAL USE OF CONCERN[12]

Although the term 'dual use' is recent, it denotes a phenomenon that is of all times. Scientific knowledge can be used for better or for worse. And the question may be asked: does the scientist carry responsibility for his or her research results being misused by others? If so, what does that mean and how can misuse be prevented?

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[10] D. Bok (2003), *Universities and the market place; the commercialisation of higher education*. Princeton: Princeton University Press.

[11] ESF/ALLEA (2011), *The European Code of Conduct for Research Integrity.* www.esf.org/www.allea.org.

[12] Part of the discussion in this section refers to my recent article P. J. D. Drenth (2012), Dual use and biosecurity; the case of the Avian Flu H5N1, *Open Journal of Applied Sciences,* 2012, 2, 123–127.

It goes without saying that desisting all research that could be misused is no solution. That would mean the end of scientific enterprise. Nearly all research is open for wilful abuse. Moreover, possible dangerous or undesirable consequences of research are often difficult to chart, especially in fundamental research with its serendipity and unpredictability.

Lately, however, the discussion took a serious turn by the realisation that abuse of biological research could assume enormous proportions. The discussion was triggered by two incidents: the nerve gas attack in the Tokyo metro, and the distribution of anthrax letters shortly after the 9—11 attack on the WTC in New York. It became clear that viruses developed in the laboratories of biologists and virologists would harbour a great danger, if they fell in the hands of evil governments or nefarious terrorists.

The US National Research Council[13] mentions the following seven classes of experiments that raise concerns about their potential for misuse: those that would,

- Demonstrate how to render a human or animal vaccine ineffective;
- Provide pathogens with resistance to therapeutically useful antibiotics or antiviral agents;
- Enhance the virulence of a pathogen or render a non-pathogen virulent;
- Increase transmissibility of a pathogen;
- Alter the host range of a pathogen;
- Enable the evasion of diagnosis or detection;
- Enable the weaponisation of a biological agent or toxin.

An interesting question, then, is how to regulate this type of research in view of this threat of malignant use. Should the scientists themselves shoulder this responsibility or should, given the fact that the threat of misuse stems from terrorists who have access to the scientific knowledge but do not share the scientists' moral imperative, national governments assume the responsibility and take action through legislation and control?

The discussion can well be illustrated by a recent case at the Erasmus University Rotterdam, where a group of virologists chaired by Ron Fouchier were able to modify in their laboratory the Avian Flu H 5 H 1 to an airborne type that was transmissible via aerosols or respiratory droplets. It is clear that this mutant, which could be transmitted through coughs and sneezes or via aerosols, could, if it ended up in evil hands, create a devastating pandemic.

Fouchier submitted his paper to *Science*. The Science editors subsequently conducted their own review also in the light of existing Codes of Conduct for Biosecurity. They sent the manuscript also to the National Science Advisory Board for Biosecurity, an independent board that advises the US government on biological research that may endanger biosecurity. The NSABB recommended publication, but

[13] National Research Council (2004), *Biotechnology Research in the Age of Terrorism,* Washington: NA Press, and National Research Council (2010), *Understanding Biosecurity; Protecting against the Misuse of Science in Today's World*. Washington: NA Press.

with restrictions: without experimental details and mutation data, and only sharing the full report with parties that 'need to know'. The risk of terrorist misuse was considered larger than the negative effects of strangling research and its publication through restrictive measures and regulations.

The authors (and most other virologists) did not agree. They pointed to the importance of openness and sharing of information as the cornerstone of scientific development. Replication should always be possible. Full information is therefore needed. Keeping things secret by sharing the information with only a selected number of colleagues is nearly impossible. To their opinion most important is, however, the benefit for public health. 'We better be prepared if such a mutation would spontaneously happen in nature'. 'And we need further research on lots of still open questions', as the argument went[14]. And another virologist Palese stated that "Slowing down the scientific enterprise will not protect the public, it only makes us more vulnerable"[15].

After a number of exchanges and further hearings the article was published in *Science*[16]after all. What is important here is the discussion on the fundamental questions of freedom of research and publication versus the restrictions posed on this for security reasons; in other words, the balance between the right to know and the dangers of knowing. My conclusion in the mentioned article was that "taking extreme positions in such a dilemma should be denounced. Both the extreme view of zero tolerance with respect to the risks of research on dangerous viruses as well as the extreme view that entirely dismisses these risks, stressing the scientific progression and public health benefits, have to be avoided. […] However, which stand one takes on the continuum between the two extreme positions remains a personal choice, but should – contrary to the often indignant reactions in the public media – always be based on full and reliable information, and result from a careful and responsible weighing of the risks and benefits"[17].

A FINAL WORD

In the foregoing we have shown that the changing world poses a whole range of meta-scientific, including ethical, questions to the scientist, for whom washing their hands in innocence or ignorance is no option. Neither is it reasonable to find the right answers to these questions in solitude. One needs a critical and intellectual discourse with other scientists and scholars. In my view, national, regional and world academies of arts and sciences are the organisations par excellence to provide a platform for such a dialogue. I seriously hope they will take up this gauntlet.

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[14] R. A. M. Fouchier, S. Herfst & A. D. M. E. Osterhaus (2012), Restricted data on influenza H5N1 virus transmission. *Science Express,* 35, no. 6069, 662–663.

[15] P. Palese (2012), Don't censor life-saving science. *Nature,* 481, no. 115.

[16] S. Herfst, RA. M. Fouchier, A. D. M. E. Osterhaus (2012), Airborne transmission of Influenza A/H5N1 virus between ferrets, *Science,* 336, 1534.

[17] P. J. D. Drenth, ibid. p. 126.

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