ALLEA

Annual Report 2003

Colophon

ALLEA - is the Federation of 48 Academies of Arts and Sciences in 38 European countries

ALLEA - advises her member academies, acts as a platform for her members and offers advises in the fields of science and science policy

ALLEA - strongly supports ethic ways of dealing with science, science policy and public policy in general.

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Preface

I have pleasure in presenting the 2003 Annual Report of the All European Academies (ALLEA). As was decided a few years ago, a more ambitious Biennial Yearbook featuring essays and profiles of a number of Member Academies appears during even years, with a more modest Annual Report appearing during odd years. Therefore, this year a more modest Annual Report.

This Annual Report first of all comprises the papers and addresses presented during the year on behalf of ALLEA . Consequently, the first is an article by the President on ALLEA's role in scientific collaboration in Europe, published in the *Institute for Prospective Technological Studies* (IPTS) report Nr. 70. This is followed by a paper on scientific integrity that the President presented to the Royal Flemish Academy of Belgium for Science and the Arts and the Belgian Academy of Medicine. Thereafter there is an article by Executive Director Schroots on ageism in science that was published in *Science and Engineering Ethics*. Next is a paper on the preservation and use of databases in scientific research, written by Van Bemmel et al. and presented at a EuroCris (current research information systems) conference. This is followed by three more papers delivered by the President: one on the growing anti-intellectualism in Europe, presented at the Slovak Academy of Sciences, a second on the basic question 'Science: does it matter?', presented at the Budapest Science Forum 2003, and a third on recent developments in European science policy, and ALLEA's point of view regarding these developments, which was written for a conference in Kiev that had been organised by the Academy of Sciences of the Ukraine.

In a second section of the Annual Report an overview is given of the activities and important communications in 2002. First to appear is a list of the President and ALLEA's activities and representations. Thereafter important letters and position papers are listed on which the Steering Committee has been consulted and, at times, the general membership. These include ALLEA's position on the first proposal in respect of the European Research Council, a letter to European Commissioner Busquin concerning his communication on the '3% initiative' (the target for Europe's R&D expenditure in 2010), a letter to the European Convention, pleading for more opportunity for basic science-driven research, a further and similar standpoint regarding the

European Constitution, an open letter to the European Research Ministers signed by ALLEA and other major European science organisations, and, finally, a proposal to the International Academy Panel (IAP) to place ‘scientific integrity’ and the role of (associations of) Academies on the agenda.

In the third section, the usual (updated) list of member academies and their addresses is provided.

I hope the reader finds the information on ALLEA’s input and views, and its contribution to the European science policy debate of interest. May this demonstrate that ALLEA, as a representative organisation of European academia as a whole, has a valuable contribution to make in pursuit of the European ideal.

Pieter J.D. Drenth	*Johannes J.F. Schroots*
President	Executive Director

Section I

Articles and Addresses 2003

European Scientific Collaboration: The Role of ALLEA*

Pieter J.D.Drenth

ALLEA is a European network of national academies of sciences and humanities. It was created when new opportunities for cooperation arose in the 90's due to the end of the cold war and the increasing significance of supra-national gremia (EU, European organizations and institutions) in the area of science and higher education. It has members from all over Europe, from the Atlantic to the Urals, from within the European Union and beyond.

There is quite some variation within ALLEA. Some Academies limit themselves to natural and life sciences. Others include, or confine their interests to social sciences and humanities. Some concentrate primarily on the forum function: scientific meetings, the exchange of ideas and opinions, the organization of conferences and symposia and international contacts. Others have, in addition, a national advisory function. They are asked to advise on science and science policy, on quality of research and future developments, and on societal and ethical questions related to science and technology. Again others bear responsibility for research, either in the form of research programmes or by administering research institutes.

In spite of these differences and this variety in roles and tasks Academies have one important objective in common: the desire to promote and to develop excellent scientific and scholarly research. They believe in the intrinsic value of scientific knowledge, and they are convinced that proper scientific research is indispensable for the desirable development of societies and the well being of mankind. The present day and certainly the future world cannot be conceived without the blessings of science and technology. But equally important for a balanced evolution are philosophy, letters and history, and the study of

* This article has been published in IPTS Report, Vol 70, December 2002 (Institute for Prospective Technological Studies, European Commission, Seville, Spain). Some of the ideas discussed in this article were expressed previously in a paper presented at the International Symposium 'The Role of the International Organizations in the Development of a Common European Scientific-Technological Space'. Kiev: National Academy of Sciences of Ukraine, 22-25 September 2001.

the constituent pillars of a civil society: law, economics and social and political structures.

How can these academies of science and humanities, and in particular associations of academies such as ALLEA, contribute to the cultivation of international science? In answering this question attention will be paid to the aspects of collaboration, communication and science policy, and we will finish with some thoughts on European scientific cooperation.

Collaboration

Science has grown from an individualistic to a collective endeavour. At present science cannot exist and grow in isolation, but necessitates cooperation, contacts and exchange of knowledge, and the opportunity to criticize and reinterpret each others findings.

And this collaboration has, of course, to cross national borders. Throughout history the international nature of science has always been apparent, but it has become particularly conspicuous in present times not the least through the widespread use of fast and powerful means of communication. Not only for participants in international cooperative research programmes but also for those who participate in local or national research the need for international cooperation is undisputable.

The need for international scientific collaboration can be substantiated on the following grounds:

a. Mondial responsibility for the advancement of science. Some of the (major) international research endeavours (CERN, ESO, EMBL) can only be initiated and supported if sufficient partners take part. This is a moral obligation for countries that are capable to contribute and to participate.
b. The need for studying phenomena and issues in a transnational context because of their supra-national nature and scope. Research areas such as environment, health (epidemic or transferable diseases), energy, transport, tourism and trade, banking and finance, and migration can only be studied fully from an international perspective.
c. The need 'to keep in touch'. It is important for researchers in any country to keep (also personal) connection with developments

elsewhere. Cross-fertilization is essential for the scientists' own motivation and for the training of younger scientists.

d. National interest. With respect to certain international questions a particular country may have a specific interest and may have to develop a distinct research capacity because of its national needs. A country may give priority to these subjects on strategic grounds, which may result in explicit national expertise (for instance for The Netherlands: fishery, civil engineering (dikes and water control), transport and trade). This may require an international distribution of tasks and priorities and international arrangements for access and usage.
e. Support and strengthening R&D capabilities in economically less advanced countries. The stronger countries have an international responsibility to assist the countries that are in less favourable conditions and with relatively weak R&D resources to help them to further enhance their research and development capacities. This may often start as assistance (aid and support) instead of collaboration (mutual benefit), but in the longer run these countries may become stronger partners. And there is no doubt that in the very long run such aid/collaboration is the best precondition for peaceful coexistence and economic balance in the world, and thus absolutely beneficial for the presently stronger western partner.

It can be defended that Academies of Science, and *a fortiori* Associations of Academies of Science, can be highly instrumental in the furthering of international research collaboration. National Academies can stimulate and influence the international orientation of scientists, they can provide financial means, or suggest names and contacts, they can commend internationalisation as one of the criteria for funding, they can internationalise the research carried out in their own institutes or programmes, and they are often the national representatives in international research organisations (ESF, ICSU, UAI, IAP and others). And it needs no argument that Associations of Academies (such as ALLEA), which are by definition operating at the supra-national level, and the foundation of which in many cases was even inspired by this need for international collaboration, can be pre-eminently salutary in the process of fostering the international orientation and collaborative activities of scientists.

Communication

The communicative function is one of the essential *raisons d'être* of (Associations of) Academies. It goes without saying that this communication has necessarily a strong international dimension. Gatherings of scientists and scholars, international meetings, conferences, colloquia and workshops, reciprocal visits of scholars, special lectures, exchange of periodicals and other publications, and membership of international organizations all emphasize the international nature of the meeting function of an Academy.

Of course, we often see the unavoidable differences of opinion and sometimes even sharp controversies. Three things are comforting, however: In the first place, these differences in opinion seldom coincide with divisions between continents, nations or political alliances. Secondly, in most scientific and scholarly discussions the differences are basically agreeable to reason; in normal cases they are never solved by means of power, force or hostilities. Thirdly, it is not generals, presidents or ministers who decide what is good or wrong, but the scientists themselves.

It is clear that for such a dialogue and debate the scientists need an acknowledged and independent platform adhered by collegiality and solidarity, and in which the political or ideological pressures and power-play are debarred. Academies at the national level, and Associations of Academies at the international level, are suitable candidates for such a role.

Policy advice

A third function of Academies pertains to its advisory role with respect to science policy, to socio-political problems that could be solved or relieved through sensible application of research findings, or to socio-ethical problems that emerge from often controversial scientific or technological research. Elsewhere (Drenth, 2002) I made the following distinctions with respect to the nature of the advices:

1. Advices based on quality assessments: advices on continuation, termination or adaptation of programmes, the appraisals of individuals, research groups or institutes on the basis of the assessment of quality of the output or achievements. Also foresight

advices, which are concerned with trends and developments in various scientific disciplines, to be used for the formulation of a science policy by government or institutions, belong to this category.

2. Advice regarding science policy, such as the balance between pure and applied science, the balance between sciences and humanities, the prioritising of research areas, forms of organization or financing of scientific research, etc.

3. Advice on political decisions, based on scientific research. These decisions can have a more long-term perspective (global change, peace and détente, energy consumption, food and hunger) as well as a more immediate and short-term character (BSE, infective diseases, mouth and foot vaccination, radiation of mobile phones).

4. Advice on ethical and societal questions that are related to or generated by scientific research. This category includes in the first place internal ethical problems that have to do with improper scientific behaviour (fraud and deceit, infringement of intellectual property rights, improper or imprudent behaviour vis-à-vis subjects of experimentation, careless behaviour with respect to the general public and the media, or disregarding 'good practices' in collegial intercourse). Secondly it includes also problems arising in the broader political-societal context of the scientific pursuit, what can be called external ethical problems: the question of justification for the choice of the subject of research, the question whether the research is sufficiently independent from 'interested' or sponsoring parties, the responsibility of the researcher for what is being done with the research results, and the ethical problems generated by the research itself (stem cell research, nuclear fission and fusion, xenotransplantation a.o.)

It will be clear that national Academies would do wise to incorporate international aspects in their science policy advices, given the strong trend towards internationalisation of scientific research in general.

The need to embody the international dimension in the advisory capacity is self-evident for the international Associations of Academies. At the world wide level the IAP (Inter Academy Panel), and at the European level ALLEA are the suitable *gremia* for such science policy advices. In fact, ALLEA, with its unique character conjoining the national Academies of Sciences and Humanities in Europe, can act as an important intermediary between science and technology policy making at the national and the European level. A two-way communication comes into play: On the one hand ALLEA can bring in a wide expertise and experience available within the national member Academies. On the other hand ALLEA can also play a role in 'translating' and contextualising the European policies at the national levels.

Europe

ALLEA has tried to act as such an intermediary with respect to the recent proposals of the European Commission: the European Research Area (Busquin, 2000), and the 6th Framework Programme (EC, 2001). After extensive consultation with its members ALLEA has offered a comprehensive commentary on the 6th FP proposal to Commissioner Busquin (ALLEA, 2001). A brief summary of this commentary will be followed by a few more extensive comments with respect to international collaboration in science.

In its reaction ALLEA has welcomed the current proposal as an important contribution towards increasing the quality of scientific research in Europe, among others by emphasizing the trans-national character of European research. Also the attention given to the relationships between research and society is highly appreciated. In this connection it is recommended that the priority area "Citizens and governance" be broadened to "Citizens, communities and quality of life", and that a new priority theme "Identity and identities in Europe" be added.

ALLEA also cautions against a too narrow definition of the fields of application in the priority areas driven by scientific developments. It further recommends keeping procedures simple and transparent, and warns against criteria and procedures that unduly disadvantage smaller research groups.

ALLEA would welcome increased research funding placed at the disposal of the European Science Foundation (ESF). It also welcomes a more clear distinction between national and European research programmes ("European added value") on the one hand, and a better tuning and synergy between the two types of programmes on the other.

ALLEA further calls to the attention that the European Research Area needs not only funding but also adequate fiscal and legal arrangements, e.g. with respect to patents, taxes, and the mobility of researchers.

With respect to the *internationalisation* of research in Europe the following observations and recommendations were made:

ALLEA underlines the global setting in which EU programmes operate, and values the openness towards participation by top scholars and scientists from all over the world. In fact, it finds the respective formulations in the proposal and the Explanatory Memorandum in several places to be more reserved than is considered desirable. In order to make Europe attractive and effective, drawing on the expertise available wherever in the world is most valuable.

As said earlier, EC/FP research should have a distinctive European added value, and national programmes should continue to support disciplinary and fundamental research that is appropriate to the national and regional settings. In the long run, however, a further shift in funding from national to supranational levels might be considered. In this connection the ESF-programme for collaborative research EUROCORES is to be encouraged. As a further intermediate step national programmes might be asked to indicate their 'national added value', i.e. to make clear why certain research and development programmes are positioned at national rather than at European level.

ALLEA also stresses the wider continental setting in which the European Union programme operates, and welcomes the opportunities for participation by researchers seeking accession to the European Union. Involving states from Central and Eastern Europe, whether seeking admittance to the EU or not, is important to those countries, for the contributions their scientists can make to planned research, and for fostering cohesion and good relationships within Europe as a whole. It also increases the attractiveness of the EU as a research setting.

ALLEA appreciates the intention of engaging in specific cooperation with the Mediterranean third countries, Russia and the New Independent States of Eastern Europe, and economically developing countries, in support of EU’s foreign and developing aid policies (Explanatory Memorandum FP6, 4.1). In ALLEA’s opinion, it would be appropriate to be more liberal in allowing participation of researchers from economically less developed countries, and permitting contributions by European scientists to research and development in such countries. These countries should be able to derive more benefit from the 6th FP than they were able to do from the previous FP's. Involving such countries is inherently necessary for studying global problems in which they are heavily involved (e.g. energy, environmental issues, infective diseases, world population, culture and linguistics, and others) and may be beneficial for the development of science, by opening up a larger pool of participating scholars and scientists, especially when the level of education in those countries rises.

Creating better opportunities for their participation is not merely a question of fairness to them, but will also benefit science itself by involving a larger number of competent researchers, and by a more complete coverage of the issues under study. It is ALLEA's opinion that, if the FP mechanisms are considered or turn out to be inadequate for encouraging scientific cooperation of the European Union countries and accession states with the New Independent States and the 'third world', a special EU programme should be established, dedicated to such development cooperation in research and higher education.

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Integrity in Science: A Continuous Concern*

Pieter J.D. Drenth

At present research organisations, universities and academies are placing scientific integrity in the spotlight. And rightly so, as I hope to illustrate in this paper. Scientific integrity should and must be a continuous concern to all of us!

This applies notably to academies of sciences and humanities. Besides their task of *promoting* science by means of lectures, discussions and the exchange of people and ideas, and conducting of high-quality *research* in their own institutions or through research programmes under their auspices, academies also have an important *advisory* role to play. Issues bearing on ethical and social questions as they relate to scientific research occupy a special place in the domain of this advisory task.

This is not to say that the advisory role is limited to problems related to integrity. The following may serve as a guideline: The advisory task of an academy could have bearing on the following four types of problems:

- advice based on quality evaluations (of people, institutes or programmes),
- advice pertaining to questions of science policy (areas that need stimulus, the balance of natural sciences and the humanities, the fundamental-applied research balance etc.),
- advice in respect of political decisions to which scientific knowledge could make a contribution (global change, epidemics, crime, immigration),
- advice with regard to social/ethical issues that are linked to or generated by scientific research.

Within this fourth category of ethical problems in science we get to deal with what I have previously denoted (Drenth, 2002) as internal and external ethical problems. The *external* category of problems refers to questions such as:

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* Address presented at the Flemish Academy of Medical Sciences in Brussels, Belgium, on October 25, 2003.

- What justifies the choice of the research topic? Is it worth knowing what we investigate?
- Is scientific research truly sufficiently independent (of clients, interested parties, sponsors)?
- How far does the researcher's responsibility extend in respect of what is being done with his results?
- Is there a need for 'no go' or 'go slow' decisions in certain cases on the ground of ethical objections to implications or consequences of insights generated by the research? One thinks of stem cell research, xenotransplantation, research into dangerous viruses, nuclear fusion or fission etc.

Internal social/ethical problems in science all refer to undesirable or unacceptable behaviour by scientists. The following are relevant:
- negligent behaviour in regard of human or animal research subjects,
- careless or inaccurate communication with the general public and the media,
- disregard of the rules of good practice when publishing, quoting and evaluating research, and
- violation of the norms of scientific integrity.

The next part of this paper shall concentrate on this type of internal unethical behaviour - the violation of scientific norms of integrity.

Trust

Trust is the most important pillar on which science rests. Colleagues should be able to rely on the honesty of a researcher; honesty in describing the phenomena (s)he observes, in reporting how these have been analysed and interpreted, and in proper referring to other publications in the field. This applies also - and perhaps more so – to society in general. Users and interested parties (clients, patients, businesses, and social institutions) are far less able to verify the correctness and the quality of the conclusions and insights that the researcher presents than fellow researchers. If other scientists and the public at large can no longer give this trust, this would sooner or later mean the end of the usefulness and relevance of science.

How does science currently fare in respect of trust? On answering this question we encounter a curious paradox: On the one hand there is much - to the point of irresponsible - trust in science. Do dangers lurk through damage done to the ozone layer, depletion of fossil energy, reduction of the biodiversity, illnesses as a result of smoking, drinking, unsafe sex...? Science will no doubt present a solution, is often the carelessness incurring, but misplaced optimistic thought.

On the other hand, we also encounter an increasing scepticism. This manifests itself in the increasing interest that various pseudo-scientific theories, such as astrology, psychokinetics, neurolinguistic programming and telepathy enjoy, as well as in the growing popularity of unscientific, sometimes occult, practices such as reincarnation therapy, homeopathy, laying on of hands and hypnosis. Alarmingly, paranormal observations of UFOs, aliens and extra-terrestrials, corn circle makers and voices of the dead, too, are taken seriously by many. Even *anti*-scientific sounds are only too often heard from newspapers and other media, with scientific researchers being depicted as sly Mephistos or Frankensteins who eagerly and disrespectfully tinker with the secrets of life through their cloning or genetic manipulation.

How can one explain this growing scepticism and anti-science attitude? Firstly we could point to science's changing *social position*. Science has also encountered the currently applicable and justifiable need for public justification. Through this disclosure, inadequacies come to light - vulnerability being the price to be paid for transparency. Furthermore, society does not always sufficiently appreciate that science is an *evolving* process in which improvements of insights, adjustments of previous conclusions, and a continuous specification of contingencies are part of normal practice. Statements and conclusions of researchers can thus often be contradictory. Thirdly, in the empirical sciences, scientific assertions very often have a *probabilistic* character. This probability is either ontic (much random variation in the object), or epistemic (too many gaps in our knowledge, measures that are too unreliable). Society, however, wants certitude and does not know how to handle probability statements that are mistaken for doubt or ignorance.

Let us concede, however, that the negative attitude in respect of science has also been prompted by honest concern and even fear. Over the years a good deal of the power to be derived from knowledge has been transferred from an omniscient God to the scientists and scholars.

But have they proved capable of using this power in a responsible way? The blessings of scientific research are, of course, manifold. But do we not perceive, at best unintentional, dangerous consequences of scientific research? Nature, peace, the sharing of affluence, health, privacy..., have they all really done well in the current explosion of scientific knowledge?

But not to a small extent this anti-scientific movement can also be blamed on the scientific researchers themselves. They do not handle the media well, are vague or arrogant, don't sufficiently differentiate between personal opinions and scientific results, are careless in respect of animal experiments, or with human research subjects, cite incorrectly, argue about the sequence of authors' names.... or, most harmful of all, violate the norms of scientific integrity. More and more cases of fraud, swindling and plagiarism seem to be making headlines these days. The harm that each of these cases does to science cannot easily be overestimated.

Scientific misconduct

Hard data on the occurrence of scientific misconduct are rare and also difficult to get hold of. Not only are researchers and their managers reluctant to hang their dirty laundry in public, but also is the line between bad or sloppy research and true misconduct not always clearly drawn, as we shall see below. Utter discretion is furthermore required; a scientific reputation is quickly harmed - harm that is very difficult to undo and that often proves to be 'fatal'.

And yet, as mentioned, an increasing number of unacceptable cases have recently been reported in the press: in my country there were the cases of a neurologist who fabricated data for an experiment that was paid for per case, of a psychologist who use dreams of text from an American colleague's work without citing him, of a biochemist who went to the press with insufficiently tested hypotheses on the treatment of Aids patients, of an environmental researcher who was forced to adjust certain for the sponsor disagreeable conclusions. Prior to this, authors such as Van Kolfschooten (1993), and Hulspas and Nienhuys (1997) had already unmasked a substantial number of cheats and swindlers. In one of his columns, the Dutch oncologist Borst speculated that while "out and out fraud' does not occur very frequently, *tampering* with data does. He compared this with lower back pain - it is there but difficult to prove.

Inevitably, cases of scientific fraud have also been revealed in other countries and, it would seem, lately in growing numbers. Thus:

- last year Nature and Science comprehensively covered the infamous case of the fraud of a group of cancer researchers at the Max Delbrück Centre for Molecular Medicine in Berlin,
- two year ago (13-9-01) Nature examined a number of shocking cases of the theft of ideas by journal reviewers,
- the Times Higher Education Supplement (27-04-01) revealed that at least 19 review articles published in the highly esteemed 'New England Journal of Medicine' had been written by researchers who had secret financial links to the pharmaceutical companies that had brought the examined medicines on the market,
- at a recent conference of the Office of Research Integrity (ORI), a unit within the American government's Department of Health and Human Services, a number of case studies were presented, including the dramatic case of the Research Triangle Institute in North Carolina, where there had been a veritable 'epidemic of falsification'; employees simply fabricated whole batches of data,
- last year we were startled by two cases of fraud in very highly esteemed institutes: in the Lawrence Berkeley National Laboratory in California data had been concocted to reveal the discovery of a new element (element 118), and in the famous Bell Labs a similar case of data fabrication was reported to have occurred (the Schönland scandal, see Physics World, June 2002),
- Denmark is involved in a conflict involving the environmental researcher, statistician Lomborg, who seems to approach, and some would say cross, the permitted margin of the selective use of data in his book 'the Sceptical Environmentalist' (Nature 16-01-03),
- recently Nobel Prize winner Rolf Zinkernagel's Institute of Experimental Immunology at the University of Zürich was accused of the manipulation of data (Nature 20-02-03),
- the New England Journal of Medicine withdrew a submitted article, since a number of the co-authors were unaware that 'their' article had been submitted, and

- a few years ago this same journal described how the pharmaceutical industry lobby applied undue pressure on researchers who were intending to publish data that it found unwelcome (Deyo et al., 1997).

The above is a selection from the generally known cases of scientific misconduct, but, as Borst indicated, the fear that unnoticed far more fiddling with research data occurs, does not, unfortunately, seem unfounded.

Apart from that, it should be pointed out that scientific misconduct is a *universal* phenomenon that has *always* occurred. Descartes was accused of plagiarising Snellius and Beekman, and Darwin of 'borrowing' ideas from his fellow countryman Wallace. Even Einstein was accused by the mathematician Hilbert of stealing his ideas on the theory of relativity (an accusation that has, incidentally, been recently disproved by the Max Planck Institute in Berlin). Pons and Fleischman claimed success with the so-called cold fusion, which could never be confirmed, and Cyril Burt concocted his high correlation between twins' intelligence test scores to support his heredity hypothesis. Sometimes it was just a matter of stubbornness: Pauling defended vitamin C's ability to heal cancer despite all empirical evidence to the contrary, the Russian Fedjakin kept believing in his polywater and the Frenchman Blondot in his N-radiation.

The nature of scientific misconduct

Thus far we have more or less lumped all forms of violation of scientific integrity together. In truth, however, we cannot tar them all with the same brush. What exactly do we mean when we talk about scientific misconduct? Anyhow we can distinguish the following three categories (see also Drenth, 1999):

First of all, *fraud*: This includes the fabrication of data, the falsification of data, the 'trimming' of the data (rounding off favourably, omitting undesirable data), and the selective use of data. In short, fraud implies tampering with data or with the presentation of data.

In the second place, *deceit*: This pertains to the deliberate violation of the rules of the methodically sound analysis and processing of data. For example, the suggestion that empirical data are available, when this is not true, gross negligence in sampling, deliberately chosen improper but ‘favourable’ analysis techniques, and the deliberately incorrect or selective rendition of others’ research results or conclusions. With deceit a colleague or reader is therefore explicitly lead up the garden path.

Thirdly, infringement of *intellectual property rights*: The best known example is plagiarism - the deliberate presentation of others’ ideas, findings, research results or texts without acknowledgement or reference, as if they were those of the author him- or herself. But there are also other forms: the pinching of ideas from a doctoral student or colleague, claiming to be the sole author of research to which others had contributed, and a journal editor or reviewer claiming the thoughts or ideas originating from a reviewed (and rejected) article.

Two observations should be made at this point:

- Not all violations are equally serious. There is variation in the seriousness of misconduct both between and within the mentioned categories. The fabrication of data is more serious than ‘rounding off’ or making use of a too small sample. Plagiarising substantial pieces of text is more reprehensible than pinching an idea from a conversation between colleagues.
- Secondly, the border between unacceptable and (still somewhat) acceptable behaviour is not always easy to indicate. Where do you draw the line between verification on a too small sample and the illustration of an argument with ‘case’ data? Where lies the boundary between plagiarism and careless citation? Was an incorrect, but ‘favourable’ statistical technique truly chosen deliberately? Is it scientific fraud or a different methodology or even paradigm?

Causes

To answer the question of what causes or fuels this corruption of science, three types of causal factors come to mind: Firstly the *pressure* from powerful persons or institutions that resist honest scientific analysis, because they are ill disposed towards or even strongly opposed to the results thereof. Historical examples vary from the Roman Catholic pressure on Gallileo to revise his heliocentric conclusion to fundamentalist Christian and Muslim opposition to the theory of evolution.

Secondly, *economic* and *financial* motives. Economic interests in research into new medicines, technological innovation or patent-directed research can be substantial and can exert such unwarranted pressure. Here too recent history offers a series of striking examples, varying from the thalidomide tragedy to the subversive activities of medical researchers in the service of the tobacco industry, and from the Chernobyl disaster to the exploded NASA explorer. At this point it is perhaps appropriate to utter a word of warning in respect of contract research to universities and research institutes that are subsidised by the government. Research within universities and large institutes is increasingly dependent on contracts with industry, the government or interest groups. In principle this needn't be wrong. It is quite possible for contract research to be independent and unbiased and to be executed strictly according to scientific rules. But there is most certainly the danger of a tendency to curry favour with the client (even if merely to secure a continuation of the research). The English expression 'he who pays the piper calls the tune' is apt indeed. In their book '*De onwelkome boodschap*' [The unwelcome message] Köbben and Tromp (1999) reveal through a host of examples that this danger is far from unfounded.

Thirdly, the researcher's own *ambition* may not be omitted; an ambition fed by vanity, the desire for fame and recognition, and the prospect of personal gain. In itself scientific ambition is not reprehensible. Neither are tenacity and strong belief in one's own views or hypotheses. Without such motivations probably no important discoveries would be made nor Nobel prizes awarded. But here we refer to a dysfunctional craving for scientific fame that leads to behaviour that crosses the limits of what is admissible.

Prevalence and prevention

As previous stated, there is not much to say about the frequency with which scientific misconduct occurs. Hard data on this subject are almost non-existent. We have also indicated that it is a universal phenomenon of all time. Yet, it is not unlikely that misconduct is on the increase. First of all for statistical reasons. The enormous increase in the number of researchers will also inevitably lead to an increase in the absolute number of misconduct cases and the resultant negative press reports. But there is more: (especially young) researchers are under mounting pressure to achieve, to record results, to deliver output, to have articles published and to be cited. Tenure appointments, membership of research schools, research fellowships of academies or national research organisations, subsidies and grants, promotions and professorships - for all these desirable aspirations one needs research results and publications, preferably spectacular ones. Add to this the above-mentioned (real or perceived) pressure from sponsors of contract research and it will be clear that a dangerous climate in which scientists are tempted to engage in unacceptable behaviour arises.

Then the second word in the title of this section: prevention. Various procedures and rules are being devised in our country and others to cope with the dangers of scientific misconduct, as well as to develop proper procedures when such misconduct is suspected. Protocols, ombudsmen, confidants, science courts of arbitration and appeal, and various kinds of sanctions are suggested, all of which are very noteworthy and useful. But of the essence is the development of a matured scientific conscience and a basic sense of responsibility of the researcher him- or herself. This is of vital importance. And the development and nurturing of these values and responsibilities, rather than the fear of sanctions or the risk of being caught, will enable science to fight and prevent misconduct and fraudulent activities.

The Academy's role

Finally, what role could an Academy of Sciences play in this? Above it was mentioned that this problem most certainly concerns the academy in its advisory role. In a modest survey among the European academies, all ALLEA members, almost common consent was expressed with an academy's vigilant, informing and often even judiciary responsibility. Also a recommendation of the European Science Foundation (2000) envisages an important task for academies in the formulation of national codes of good scientific practice and in the initiating of discussions on the most suitable national approach to this problem.

Obviously a good few things are already occurring which have been implemented or initiated by academies. The American National

Academy of Science has published a superior brochure 'On being a scientist' (NAS, 1989, 1995 2nd edition), the KNAW (Heilbron et al. 2000) in the Netherlands produced a booklet a few years ago that not only described the rules of good practice, but also presented a number of real or imagined (but realistic) cases of ethically unacceptable behaviour or ethical dilemmas, to be used as discussion material for the training of researchers. Many European academies have developed or published a Code of Science, or function as an advisory board or science court in ethical cases.

Yet some co-ordination within Europe would be useful without this meaning that uniform rules and procedures need to be developed for all European countries. With this purpose ALLEA has adapted a recommendation by the Royal Netherlands Academy of Arts and Sciences ('Notitie wetenschappelijke integriteit'), translated it into English and offered this 'Memorandum on Scientific Integrity' for the perusal of all ALLEA's member academies. This Memorandum urges the founding of a National Committee for Scientific Integrity (NCSI) that can serve as an advisory board or science court of appeal in those cases of violation of scientific integrity where the settlement by the (primarily responsible) management of the institute or university is found to be unacceptable to one of the relevant parties. In the Netherlands such a body (LOWI) has been founded by the Royal Academy in close consultation with the National Science Foundation (NWO) and the Association of Universities (VSNU). We keenly await its first activities. It is not ALLEA's intention to have this formula exactly copied by other European countries, but by offering this model it aims to stimulate the discussion on the most desirable approach, to stipulate a possible helpful role of Academies of Science, and, if possible, to co-ordinate a European approach to the phenomenon of scientific misconduct that can be so injurious for science.

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Ageism in Science: Fair-play between Generations*

Johannes J.F. Schroots

This paper discusses the role of age in scientific practice from an ethical perspective. In social perception, people tend to categorise others rather automatically along three major dimensions: race, sex, and age (Kunda, 1999). Much empirical and theoretical attention has been devoted to the study of racism and sexism, but comparatively little research in the social and behavioural sciences has been directed at understanding what some refer to as the third '-ism': *ageism* (Barrow & Smith, 1979). For a serious understanding of the implications of ageism in science, it is necessary to discuss, first, the conflicting relationships between classical and modern concepts of time and calendar age, and thereafter the concept of ageism.

On time and age

In Western society, Newton's physical time – also called calendar or clock time – plays the role of standard continuum, a frame of reference for other continua of changes such as biological or psychological time. Different concepts of time may have different clocks and time scales, but their scales are always compared with and expressed in terms of calendar time (days, months, years) or clock time (hour, minutes, seconds).

Newton's physical time does not have intrinsic direction; there is no difference between its past orientation (t-) and its future orientation (t+). As such, the classical concept of time violates generally accepted natural laws. Natural phenomena are described by the second law of thermodynamics, which states that chaos or disorder will increase *irreversibly* with energetic processes. Thus, the direction of physical

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time is defined by the irreversible destruction of macroscopic order, or the increase of entropy.

The modern concept of time as linear and irreversible has not changed our conception of calendar age as *additive*, that is, a quantity that can be added, subtracted, multiplied, and divided regardless of the age of the individual or organism. The implication is that all possible calendar ages of the individual are equal. For instance, the first 20 years of life are equal to the middle or last 20 years. Similarly, the first half of an academic career (25 - 45 yrs.) as a junior scientist would be equal to the last half from 45 to 65 years as a senior scientist, which is the mandatory retirement age in most European countries. This, however, makes sense only from a purely clock or calendar time perspective (Schroots & Birren, 1989). In the following we will show that different generations in science are not interchangeable and that the mandatory retirement age is built on quicksand.

Ageism

During the past two centuries the place of calendar age has shifted. In comparison with the 19th century, it has assumed surpassing importance, corresponding to a general *quantifying* trend in science. This corresponds to a generally egalitarian norm within society, namely, to treat people independently of personal characteristics – *except for age* (Back, 1995). Analogous to sexism, *ageism* can be defined as *the negative stereotyping and discrimination against people solely because of their age.* It should be noted that in this definition no distinction is made between people of different ages. Both young and old people, or younger and older scientists for that matter, may be discriminated against or stereotyped. More common, however, is the definition of ageism as the negative stereotyping and discrimination against *older* people.

Following the latter meaning, ageism is manifested in a wide range of phenomena, on both individual and institutional levels – stereotypes and myths, discriminatory practices in housing, employment, and services of all kinds, intergenerational segregation, education, health care etc. Some of the myths of age include inflexibility, senility, disengagement and unproductiveness. As we will see, gerontological research shows that these stereotypes are spurious – they are based on myths and are contradicted by empirical facts (Schaie, 1996).

Generally, the persistence of ageism is attributed to its roots in basic values, such as the glorification of youth, individualism, economic competition and the reduction of human worth to economic utility. In this context Nelson (2002) makes a striking observation: "One of the unique features of ageism is that age, unlike race and sex, represents a category in which most people from the in-group (the young) will eventually (if they are fortunate) become a member of the out-group (older persons). Thus, it seems strange that young people would be prejudiced toward a group to which they will eventually belong. Where does this negative affect originate?" (p. *x*).

There are two standard explanations. First, recent research shows that people have multiple, often contradictory views of older persons. Today's elders are seen as incompetent, which is associated with low status, but also as warm, which is associated with a passive attitude (Cuddy & Fiske, 2002). Second, Greenberg, Schimel and Mertens (2002) suggest that age prejudice arises from fear of our own mortality; that is, merely thinking about (or seeing) an older person tends to arouse anxiety about the fact that one has a short time on earth, and the fear associated with such cognitions tends to provoke the perceiver to dislike the individual (or group) who elicits such fear. To these accounts a third explanation, based on a special characteristic of human memory - the so-called 'bump' phenomenon - should be added.

Autobiographical memory bump

Autobiographical memory can be broadly defined as a type of episodic memory for information related to the self in the form of memories. As such, autobiographical memory obeys generally to classic principles of remembering and forgetting, e.g., the distribution of memories follows a power function, similar to the classic forgetting curve. Contrary to these principles, the *bump* phenomenon represents a disproportional higher recall of memories from the period between the tenth and thirtieth year, as systematically observed in individuals older than approximately 35 years. Peoples' favourite films, music, and books come from this period and they report the most important world events to have originated or occurred in it (Rubin, Rahhal & Poon, 1998). As yet, there is no satisfactory explanation for the memory bump, but it may be assumed that the paradoxical peak of memories from between the ages of 10 and 30 years stems from the synchronic action of two life forces, i.e., the force of growth or development, and the force of mortality or aging (Schroots, 2003). The significance of the memory bump can be demonstrated by way of a very simple formula,

$$P_w = C + (20 \pm 10)$$

in which: P = Period (yrs)
w = world-view
C = Cohort (birth)

This formula states that the individual's world-view or frame of reference (P_w) was formed in the period between the ages of 10 and 30 years. For example, in the year 2003 the world-view of a 60-year old scientist or scholar was formed in the historical period between 1953 and 1973. It is the task of cultural historians and sociologists to characterise that period, but one may safely say that the majority of today's 60-year old scientists and scholars experienced or witnessed the student revolution at the end of the sixties while studying.

In the bump period of their life people start dating, have their first relationships, are educated, look for their first job, feel physically strongest, become politically aware, go to the best movies of their life, read the most memorable books, listen to their most loved music, and experience their most intensive learning. In brief, the *bump period* is the *cognitive-affective frame of reference* from which middle-aged and older people view life in general, and relations, work, health and education in particular. No wonder that older generations in science who live and work from this perspective, are stereotyped as unproductive and are discriminated against because of their age.

Generations and ageism in science

The concept of generation often denotes successive groups in time. Generations occur within lineages or descent lines – but not necessarily so. The individual and his/her parents and children comprise three distinct (biological) generations. Similarly, the scientist and his/her mentor and students could be conceived as three generations in science. From a biological perspective the temporal distance between two generations will generally represent a time frame between 20 and 30 years. With the bump formula in mind, it is conceivable that science generations are also 20-30 years apart. This means that at one point in time one could distinguish approximately two generations of scientists who are active in their field, either as a student or junior scientist at the start of his/her career, or as a professor or senior scientist. For the sake of simplicity they are called the young and old generation. The table below shows some ageist stereotypes that younger generations of scientists might have against older scientists (right column), and vice versa (left column).

Ageism between Young and Old Generations in Science

Old against Young	*Young against Old*
- inexperienced	- unproductive
- self-assertive	- inflexible
- impatient	- not creative
- inflated ego	- authoritarian
- threat to one's chair	- career obstacle

It should be noted that the ageist stereotypes are based on the first definition of ageism, which doesn't distinguish between people of different ages, and/or younger and older generations of scientists. The phenomenon, as observed by Nelson (2002), that junior scientists could be prejudiced toward senior scientists, a group to which they will eventually belong, should also be noted. But then, of course, a common feature of these two groups has not yet been mentioned, i.e., their *interdependence*. Both groups depend on each other, just as students need teachers and teachers need students.

The second definition of ageism in science, which concerns the one-sided, negative stereotyping and discrimination against older generations, raises the question whether the interdependence of younger and older generations of scientists is symmetrical or *asymmetrical*. This definition refers to the traditional relationship of the two science generations in terms of master and mate, or – more correctly – professor and student, a distinction that in the final analysis refers to a merit system instead of generational equity.

Generational equity

In our modern welfare state the concept of generational equity has acquired increasing importance. Broadly defined with a view to the scientific community, generational equity means that according to their needs and regardless of their age there is a fair distribution of the available resources among all generations in science. According to this definition, an ethical issue arises when one generation is treated more leniently or generously than another (Wisensale, 1988). For example, in some countries loans for college students are subject to means tests for eligibility, but social security entitlements are not.

Generational equity is commonly framed in terms of conflict between young and old and between the working and non-working (or retired) population. The question is whether this concept should be introduced in the scientific community as a remedy for the disease of ageism in science. It can be argued that equity is always morally justified, but then a couple of comments should be added. The first comment concerns the pseudo-additive character of calendar age variables, in this case, the *pseudo-additive* character of the generational variable, as discussed before; that is, generations are interdependent but not interchangeable. The second comment relates to factual information from the behavioural sciences on the life span patterns of *mental abilities*. General intelligence can be divided into two types of mental abilities, i.e., 'fluid' or spatial-analytical abilities, which refer to basic processes of information processing, and 'crystallised' abilities, which refer to cultural knowledge and experience. Both abilities show a rapid rise until early adulthood (ca. 20-25 yrs.), followed by a period of relative stability until the age of 70 for the crystallised abilities, but a slow decline of the fluid abilities after early adulthood. In brief, the pattern of mental abilities is that of differential decline over the life span with a peak for fluid abilities (abstract reasoning) in the bump period between the tenth and thirtieth year, while the crystallised abilities of cultural knowledge and learning experiences continue to increase over time (Schaie, 1996). From the perspective of mental abilities there is no generational equity.

Fair play between generations

In a recent paper, liberally referred to in the following, Drenth (2002) discusses the old distinction between quantitative and qualitative methods. *Quantitative* or nomothetic methods are dominant in science and have been very successful, but are also weak in addressing real life problems, which are usually characterised by a complex organisational structure. *Qualitative* or ideographic methods, on the other hand, are more suitable for the description of contextual complexity, the detection of patterns of events etc. Gibbons et al. (1994) distinguish between Mode 1 and Mode 2 research. Mode 1, that of knowledge production, is described as disciplinary and homogeneous, and the scientific orientation as basically structural/nomothetic. Mode 2 is transdisciplinary and far more heterogeneous in terms of methods and approaches; also descriptive and other qualitative methods of data gathering are allowed.

The quantitative, nomothetic, mode 1 research represents a culture which is not only dominant in the sciences, but often also financially successful; top research is conducted mainly by junior scientists at the peak of their *fluid* abilities. The qualitative, ideographic, mode 2 research, on the other hand, is exemplary of the humanities. This type of research appeals largely to the *crystallised* abilities of scholars and does not provide any direct economic utility. This pattern of differential decline across generations explains why senior scientists – once over the hill at the age of 30 and living on their successes from the bump period – become increasingly obsolete from a short-term, economic perspective (publish or perish, no longer innovative etc., etc.), while the accumulated knowledge and experience of senior scholars allow them to mature until far in their sixties and become even more productive in respect of the analysis of complex historical and social problems.

From the above it seems that junior scientists and older scholars have a clear advantage, and that particularly senior scientists have hardly anything to offer. Such a viewpoint is rather short sighted for two reasons. First, the older scientist has acquired a wealth of experience, although hardly valued in society, which he or she can pass on to the next generation in the role of *mentor*. Second, in spite of the appearance to the contrary, older people do have an as yet unexplored *potential* for personal and cognitive *growth* that is waiting to be discovered and used in daily life (Schroots, 2003). Fair play between generations in science is more than direct economic utility; in the final analysis it is about the sustainable development and distribution of mental resources among all generations.

Summary and conclusion

This article discusses the role of age and the concept of ageism in scientific practice from an ethical perspective. Different generations in science and the humanities have different strengths and weaknesses as regards their mental abilities over their life span. Older scientists are stereotyped as unproductive, while younger scientists are looked upon as inexperienced. From a short-term, utilitarian perspective, older scientists are generally less valued, but in the long term and in view of their abilities at an older age, they can have a strong impact as a mentor of future generations, a quality completely ignored in modern society as expressed, for example, in the mandatory retirement age of 65. Younger scientists, on the other hand, are highly esteemed for their creative contributions to the economy, but lack experience to put their findings in a broader socio-cultural context. Since traditional relations between younger and older generations of scientists are slowly failing, the extended concept of generational equity is introduced as a remedy for ageism in science, i.e., generational equity relates both to the sustainable development and fair distribution of mental resources among all generations.

In conclusion it is suggested that good scientific practice in research and scholarship should develop a progressive science policy of flexible retirement, continuous education and career development for both young and older scientists and scholars, in brief, *fair play between generations.*

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Databases for Knowledge Discovery: Examples from Biomedicine and Health Care

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At present, there is no longer any area in which scientific research is not supported by computers. In physics, chemistry, and engineering, mathematical models are being built on the basis of scientific and technical knowledge to simulate different processes so that researchers can obtain better insight into how those processes work. The interaction between theory, experiments, and simulation enables the researcher to formulate a better theory, to increase his or her knowledge, and to better control the processes that are studied. Examples are the computer simulation of chemical processes in an oil refinery, a computer model of the behaviour of an airplane in a wind tunnel, or the virtual computer manipulation of complex molecules and their interactions. Other applications of the use of computers deal with the acquisition, storage, and analysis of huge data streams, such as in astronomy or earth observation by satellites. These applications provide images that are analysed by computer, for instance, to monitor objects that have been identified earlier or to detect new events. Weather forecasting is another example of an area in which large amounts of data from satellites and weather stations are fed into complex models running on supercomputers for the prediction of atmospheric pressures, air currents, and temperatures. All such applications give rise to large research databases.

Computers are used for text analysis and the storage and classification of data in other disciplines as well, such as the arts and history, theology and philosophy, psychology and the social sciences, economics, and management research. Data are obtained, e.g., from behavioural studies on individuals or from stock exchanges, and algorithms are being developed to support data interpretation and decision-making.

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This brief overview is only a snapshot of the use of computers in scientific research. Many of the models and algorithms that have been developed, however, stand on a weak scientific footing if they are based on subjective findings only. Perhaps this holds less for research in the mathematics-based disciplines such as physics and engineering than for the other less formal disciplines, such as sociology and economics, in general, the humanities. Somewhere in between the 'hard' sciences, such as physics, chemistry, and engineering, and the 'softer' disciplines, such as the humanities, lay disciplines that have both 'soft' and 'hard' characteristics. Examples are psychology, biology, and medicine and health care. This is the reason why the application of computers in the latter areas has, on the one hand, a rather formal, sometimes even mathematical character but also, on the other hand, a relatively diffuse and fuzzy nature if data are derived from studies with humans. The question is, then, whether it is still possible under such 'soft' scientific circumstances to use computers in a way similar to the way in which they are used in the 'hard' sciences, that is, for the development of models and algorithms that deliver reliable and scientifically trustworthy results. A second question is whether the use of computers in scientific data analysis is not limiting the creativity of the researcher. Such questions are relevant for the full domain of the 'hard' and the 'soft' sciences. Therefore, we have selected our illustrations from the field in which we have conducted our research all of our lifetimes: the biomedical and health sciences.

In the following section we discuss some examples of the use of computers from the extremely broad area of biomedicine and health care, which can be subdivided into three branches:

1. Fundamental biomedical research, which is mainly related to the 'hard' scientific approach, as we see in physics and engineering, e.g., with the advent of high-throughput technologies;
2. Clinical research, which in many cases uses rather 'hard' data but which sometimes also uses very subjective observations; and
3. Population-based research, that is, research with data on populations of healthy and ill persons. This type of research can be subdivided into prospective and retrospective research.

Although the examples that we present are from the biomedical field, they are, in our opinion, largely representative of the use of computers in scientific research in general. In presenting the examples, we will restrict ourselves to one overall theme only: *the discovery of new scientific knowledge from large databases of measurements, observations, and interpretations*. This restriction is necessary, because the field of computer applications in the biomedical and health care field is itself extremely broad (Van Bemmel & Van Musen, 1997).

Changing Frontiers in Research

Until only 10 years ago biomedical research was primarily concerned with the further sophistication of the knowledge in areas such as physiology, anatomy, embryology, and immunology. All of these areas have long traditions as being among the basic disciplines of medicine and health care. Fundamental research in biomedicine was generally done with organs and organisms. Nowadays, however, the fundamental challenges lay a magnitude lower; that is, research is primarily conducted at the level of molecules and cells, which is the effect of the unravelling of the genome and the proteome. However, this does not imply, as one may suspect, that research at the level of organs and organisms is of no longer of interest; on the contrary, the results from breakthroughs at the level of biomolecular research are translated to the level of organs and organisms. For that reason this type of research is often called *translational research*. Therefore, genomics (the study of the genome and the genes) and proteomics (the study of the proteins produced by the cell on the basis of the information encoded by the genes) have a profound effect on research projects in two other branches of the biomedical field: clinical research and population-based research. At the same time it should be realised that not all biomedical research is suddenly transformed into projects exclusively connected to genetics and proteomics. It will still take a considerable amount of time before the newly gained insights in the molecular biology branch of biomedicine have been translated into clinical applications, i.e., new diagnostic techniques, therapies, vaccines, and drugs. Yet, the most challenging frontier of scientific research is where the different disciplines and approaches meet: the crossroads of biomolecular research and genetics and clinical and population-based research.

Databases to support biomedical research

Research in the areas of genomics and proteomics - and, related to these areas, bioinformatics - is growing exponentially. In all countries, in particular, in the USA and Europe, the number of research projects is extremely large. No individual biomedical researcher or even research group is able to cope with the avalanche of publications in the scientific literature, and no researcher can afford to spend more time reading articles than paying attention to his own research. The number of abstracts in the MedLine database, which contains 11 million refereed biomedical publications, grows at a rate of 500,000 per year. Databases containing gene and protein sequences and related data are growing at an even higher rate. All such articles and molecular sequence databases may contain valuable information for one's own research and clinical applications. We are therefore confronted with a huge problem: on the one hand, no one wants to miss essential scientific information, but on the other hand, no one has enough time to browse the refereed literature, let alone synthesize the required knowledge from it.

In this respect there is one more point to make: in scientific research one should have an open mind for the unexpected, that is, to discover something that does not logically follow from earlier research, a phenomenon that is called *serendipity.** The human mind, in particular, the mind of the creative open-minded researcher, is able to make such new discoveries. Wasn't it Isaac Asimov, who said that in science the issue is not particularly '*Eureka*!' ['I found' (what I was looking for)], but rather '*Hey, that's funny!*'? It is especially the unexpected finding that triggers the curious investigative mind to formulate new hypotheses and to look for relationships between phenomena that were previously unheard of. And here is the key problem: because of the exponentially growing amount of literature, such relationships between one's own findings and those of others can hardly be made—there is far too much scientific literature to be read.

Filtering the literature

In principle, search engines, such as the ones available on the World Wide Web, could solve retrieval questions based on simple Boolean

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* Coined by Horace Walpole (1754) after *The Three Princes of Serendib* (i.e., Ceylon), a Persian fairy tale in which the princes always make discoveries of things they were not in quest of by accident and sagacity.

expressions. On the other hand, however simple or complex such Boolean expressions might be, the user should know in advance what he is looking for, based on the knowledge that he already possesses, and in this way he will not find something outside his direct scope of interest, at least most of the time. In addition, such Boolean expressions may serve as a 'filter' on the literature and narrow the number of articles that one should read. However, if such filters are too precisely defined, they will provide only those articles that cover a narrow field; if the filter is too broadly defined, the procedure will generate an avalanche of articles. Neither of these possibilities may be what the researcher is looking for. Thus, there is a need for more advanced algorithms, ideally, algorithms for procedures that can 'learn' from the user's scientific interests.

In principle, there are two approaches to the discovery of new knowledge from refereed publications: one can be called the 'forward approach' and the other can be called the 'inverse approach.' The forward method starts with what the user already knows (he defines the Boolean expression, that is, the filter, which in this context is called a 'fingerprint') to analyse the literature; the other is based on finding new (unexpected) concepts, which in a way is related to serendipity.

In the recent past, several research groups have started projects in which they use large literature databases and fast computers to automatically find unexpected relationships and to formulate hypotheses (Ng, 1999; Lindsay & Gordon, 1999; Rindfleisch et al, 2000; Sekimizu, Park & Tsuji, 1998; Stephens et al., 2001; Van Muligen et al., 2000; Smallheiser & Swanson, 1998). This area of research is also referred to as 'data mining.' Some of the approaches that these researchers follow are very advanced from the viewpoint of semantic text analysis. They may also assist in generating hypotheses on the basis of a large collection of publications from their own group and other researchers. For instance, if one set of documents describes the relationship between Property *A* and Property *B* and a second set describes the relationship between Property *B* and Property *C*, but no documents describe the relationship between Property *A* and Property *C*, then it is important that the algorithms be able to detect the latter association. Smallheiser and Swanson (1998) conducted pioneering work in this direction in the framework of the so-called ArrowSmith project. Below we discuss the methodology developed by the team at

Erasmus University, which builds on the Collexis technology (Van Mulligen, 2002).

Forward approach

In the first approach, the forward approach, the computer may be used to make a 'fingerprint' of one's own field of scientific interest, for instance, by the analysis of one's own publications. In this phase the computer is fed two databases: one large database or thesaurus contains well-defined terms pertaining to research in a specific discipline, such as biomedicine, and the other database contains the researcher's or the research group's own publications. Ideally, the thesaurus of terms (the ontology database) is also able to cope with synonyms (different words, but with the same meaning or semantic expression) and, in combination with contextual analysis, homonyms (the same terms, but with different meanings). In the first step, then, the computer searches for those terms in one's own publications that are occurring at a certain frequency, but at the same time it also searches for combinations of terms in a given context. This is something that cannot easily be done by the researcher himself, because it would take far too much time, in particular, when context, synonyms, and homonyms are taken into account. The result of this first phase is the fingerprint of one's own research profile, which the researcher can modify and refine if desired. This fingerprint—together with other fingerprints that one wants to use—is stored in the computer and is used to search the literature in one's field of interest. The forward approach is extremely useful for monitoring the current literature and keeping abreast of progress in one's field of interest.

Inverse approach

The inverse approach is, in a way, related to making new discoveries, that is, serendipity. Here, the computer is used to search a large database for the co-occurrence of certain terms or concepts that are known, e.g., terms or concepts from the ontology database, and to show relationships between such concepts in a graphical form to the user. The different concepts are given a location in a high-dimensional terminology space, in which an interconnecting line indicates related concepts. The more frequent the relationship between the concepts is, the shorter the distance and the interconnecting line are. Of course, this relationship can be depicted for more concepts simultaneously. Interconnections that do not occur frequently enough can be omitted from the graphical display. This method is able to compute the various distances between concepts in multiple dimensions, taking into account the co-occurrence of each concept among massive amounts of other concepts. On the basis of this technology, once the system has had a sufficient amount of time to learn, the proximity of two concepts seems to have a strong biological meaning. Even concepts that have not been mentioned together in any of the fingerprints used to feed the system can end up close to each other and could predict potential relationships in the literature, which normally stay undiscovered because of their complexity. Here, in the same way as in the first phase of the forward approach, the computer is fed data from two databases: one with terms from the ontology database and the other with refereed publications, but now without an already existing user fingerprint. The computer searches for terms that occur at a certain frequency and tries to find associative relationships between terms and patterns of words among articles from different research groups. At this stage, of course, it has no ability to ignore trivial relations that are already known, such as the fact that *malaria* is a *tropical disease*. To discern trivial from new relationships is a task for the 'intelligent' searching algorithm.

Some developers of these search techniques use only abstracts as inputs into the system; others, such as the team at Erasmus University, also use the full texts of articles and, if necessary, include article citations as well. When a number of relationships are found, the user may inspect them interactively and instruct the computer to trace the associated publications for a closer study. The same method can also be applied to databases of documented genes or proteins or to any other well-documented database with a semantic content.

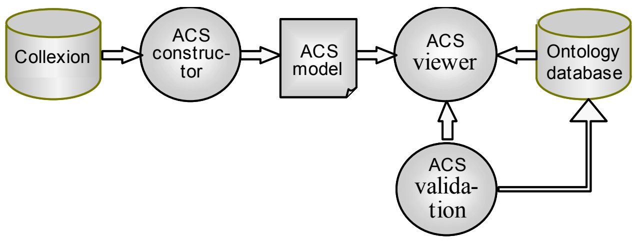

Figure1. On the basis of a collection of concept-indexed sets of publications, the associative concept space (ACS) constructor can create an ACS model that shows the concepts and their relations in an Euclidean space

Ideally, the system is able to formulate new hypotheses (associations) with the help of the ontology database. On the basis of a collection of concept-indexed sets of publications, an associative concept space (ACS) constructor can create an ACS model that shows in Euclidean space the concepts and the relations between them (see Fig. 1). Concepts that are highly associated appear close together and can be inspected by experts. The validated relations, which are in essence new knowledge, are stored together with the knowledge contained in the thesaurus in the updated ontology database. The user can use the latter for better filtering and visualisation.

In their biomedical applications, the team at Erasmus University started with the ontology database of the National Library of Medicine, the Unified Medical Language System (UMLS) (Lindberg, Humphreys & McCray, 1993), and combined it with a genetic ontology database, which was derived from the genetic and proteomic databases Genew, LocusLink, SwissProt, OMIM, and GDB. Their method has been successfully applied to large collections of publications in the literature, for instance, the journal *Nature Genetics*, to find relations between genes, proteins, and other data. Once relationships are found, they are offered to experts in the field, who may inspect them for validity.

Databases to support clinical research

Clinical researchers use computers for a multitude of tasks, from the development of large systems for the structured documentation of patient records to the digital storage and processing of three-dimensional imaging data. An important area is the use of computers to assist clinicians with formalizing medical knowledge for diagnostic and therapeutic decision-making. One method is the so-called knowledge-engineering approach, in which clinicians elucidate and structure the medical knowledge that they possess. Knowledge in textbooks or clinical guidelines may also be taken into account. Retrieving expert knowledge from the brain of a human expert is a time-consuming task, equal to the extraction of knowledge from the literature, as we have described above. The main problem here is that experts experience difficulties in expressing the medical knowledge that they routinely use in their clinical decision making in sufficient detail and precision. Apparently, they are more accustomed to using such knowledge in a 'forward' way than in an 'inverse' way. Therefore, computer-learning techniques are used in several other areas as well, such as in robotics and machine learning or for traffic control. In addition, researchers in the biomedical field have developed algorithms that automatically generate decision rules from a collection of well-documented patient data (Kors & Hoffmann, 1997). In the same way that was explained above for the inverse approach, these techniques also allow the discovery of new associations that may advance medical insight and improve decision-making. As stated earlier, this approach is known as data mining.

In principle, there are two main lines of research for decision support. The first one generates comments on the decisions that the clinician has made but does not impede his responsibility, leaving it fully intact. This is referred to as the 'critiquing approach.' The other approach is automated clinical decision making. We prefer to call the latter approach the 'classification approach,' reserving the term 'decision' for the final human interpretation. The first approach is used in circumstances in which clinicians must make clinical decisions about an individual patient. The second approach is used in cases in which many decisions must be made within a short time frame (for instance, in population surveys) or when the analysis and interpretation of the patient data are too complex (for instance, in the interpretation of biochemical analysis, in the monitoring of intensive care patients, or in the analysis of medical images or biosignals). The following sections provide examples of each approach.

Critiquing

Ideally, a critiquing system looks over the shoulder of the clinician, as if it was functioning as a watchdog, and generates a warning only if the clinician deviates from the state of the knowledge in his profession. To reach that goal, several research groups have attempted to integrate a critiquing system with the routine practice of the clinicians. For a smooth integration, it is necessary for the clinician to make use of an advanced computer-based patient record (CPR) system, which is a line of research in which we have invested a great deal of time and effort as well but which will not be discussed here (Van der Lei et al., 1993). The reason for using a CPR is as follows. When the data that are needed as input for the critiquing system are already present in the

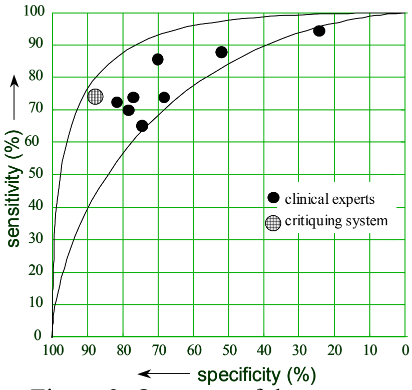

Figure 2. Outcome of the assessment of HyperCritic. The performance of the critiquing system was comparable to that of 8 clinical experts.

CPR, the 'watchdog' can run as a background task on the same computer and will 'bark' only when too large a deviation from commonly accepted standards and guidelines is detected. The use of a CPR also avoids the need for double data entry, which helps prevent a work overload for the clinician. Therefore, our research team has developed several critiquing systems that review and generate comments based on the data already available in the CPR.

An early critiquing system that we developed for diagnostic support was HyperCritic, which offers comments to general practitioners (GPs) about their treatment of hypertension (Van der Lei et al., 1991). The 'forward' knowledge was derived both from the literature and from eight experts in hypertension therapy. To test the critiquing system, data on practices in primary care were collected in a large database, and the eight experts in hypertension therapy validated the data. Their joint 'verdict' was used as the yardstick or 'gold standard' for comparison with the outcomes of the critiquing system. The verdicts of the experts themselves were also compared with this gold standard. In this formal assessment study, the critiquing system appeared to function at the same level of accuracy (i.e., with the same sensitivity and specificity) as the experts (see Fig. 2). This has been depicted in Fig. 2 as a receiver operating characteristic (ROC), a term borrowed from radar technology. The two curved lines are two ROCs, each with a different diagnostic performance. Diagnostic performance improves when the line approaches the upper left corner in the graph (10% specificity and 100% sensitivity). The HyperCritic system is located on the better of the two ROCs.

Decision-support systems

In the following we discuss two examples of automated decision-support systems in which clinicians are confronted with large numbers of cases and the need for a specialised and rather complex interpretation of the data.

The first example pertains to a request for laboratory analysis. The second one pertains to the computer-assisted analysis of an electrocardiogram (ECG).

BloodLink controlled clinical trial	**Control Group**	**Guideline-Group**
No. of practices	21	23
No. of GPs	29	31
No. of patients	97,177	98,432
Sickfunds	52%	52%
No. of order forms	12,786	12,700
% of forms generated by BloodLink	89%	73%
No. of requested tests	87,634	**70,479**
Average No. of tests per order	6.9	5.5

Table 1. Outcomes of the assessment of the critiquing system BloodLink for the request of laboratory analysis in primary care. The number of laboratory tests was 5.5 when using the critiquing system against 6.9 in a control system.

The first decision-support system is a very practical one and is called BloodLink. BloodLink assists the GP with requests for laboratory analysis for a wide spectrum of conditions encountered in primary care patients. When a GP is confronted with a patient whom he suspects of having, for example, liver disease, the GP may confirm his assumption by requesting certain laboratory tests. However, in principle the GP may request hundreds of different tests on the patient's urine, faecal, or blood specimens. If the GP asks for too many tests, he might be overwhelmed with results and be confronted with false-positive outcomes; if he asks for too few tests, he might underdiagnose the disease. Faced with such problems, the medical profession has developed protocols or guidelines that instruct the clinician on what tests to request for particular patients and under what circumstances. However, it is too big of a burden for a GP to keep all of this knowledge about guidelines operational and continuously updated in his brain. Therefore, the knowledge contained in these guidelines was formalised and transformed into a computerised decision-support system. We implemented the system in a real clinical environment and performed an extensive assessment study. The outcome of that formal evaluation was that the support system increased both the quality and the efficiency of laboratory requests in primary care (Van wijk et al., 2001). The number of laboratory analyses requested decreased from 6.9 per consultation for the control group to 5.5 per consultation by the users of the support system (Table 1).

Another decision-support system that we developed (called MEANS, for Modular ECG Analysis System (Van Bemmel et al., 1990)) performs ECG measurements and generates a diagnostic interpretation. Two different, fairly large and well-refereed databases are required for the training and clinical evaluation of a decision-support system like MEANS: one is required for 'training' of the system, that is, for the implementation of the correct medical knowledge and decision algorithms; and one is required for the independent assessment of the ECG interpretation systems, preferably in comparison with other, similar interpretation systems commonly used throughout the world. The latter has been done in a large international study supported by the European Commission, in which MEANS and similar interpretation systems were extensively evaluated (Willems et al., 1991). The outcome of such an evaluation can, for instance, be depicted as a matrix of correct against incorrect (or partly correct) diagnostic classifications. The overall performance of such an interpretation system can also be expressed on a graph, in which the performance of the interpretation systems is plotted against the true diagnosis (see Fig. 3). In our case, two types of 'true' diagnoses were obtained from two different sources: (1) the joint ECG interpretations from a group of cardiology experts and (2) the diagnosis as stated by ECG-independent clinical data. Both sets of true diagnoses were used, and the overall diagnostic interpretations of the ECG interpretation systems were compared with these two true diagnoses in a database of 1,200 well-documented ECGs, as depicted in Fig. 3. The diagnoses of the clinical experts were also compared with both true diagnoses (Fig. 3), and it was found that the clinical experts performed slightly better than the interpretation systems. However, although the latter may be true for the experts, it may not hold in general for average or, perhaps, less-than-average clinicians.

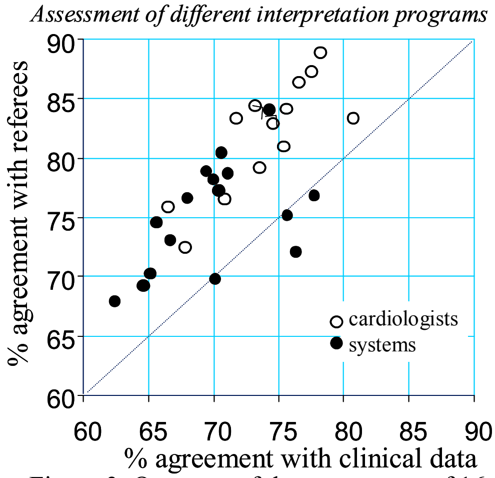

Figure 3. Outcome of the assessment of 16 ECG interpretation systems by means of a database of 1,200 well-documented ECGs. Horizontally, agreement is depicted with independent clinical data and vertically with the average interpretations of 13 trained cardiologists. The open circles represent the cardiologists, the dots the systems. Expert cardiologists performed overall still better than some svstems.

Systems for the interpretation of ECGs have successfully been introduced in clinical and primary care practices and are also used in large population screening studies (Kors et al., 2000). It is clear that no system should take over the responsibility of a trained clinician. As we stated above, such systems generate classifications of medical data rather than final medical decisions.

Databases in population-based research

The preceding descriptions of the use of databases of well-documented data from patients, healthy individuals, and the literature are good illustrations of the use of computers to support scientific research and clinical practice. Health sciences research is an area in which a methodological approach to medical and health problems is used, such as in epidemiology, biostatistics, and medical informatics. Many studies in this area are conducted by analysing the data from retrospective or prospective studies collected in databases. We give a few examples of such research.

Retrospective research

Every Dutch citizen belongs in principle to one GP practice in primary care, with the GP acting as the patient's gatekeeper to the health care system. Usually, patients stay with their GP until they move to some other place. In the Netherlands, almost all GPs nowadays use CPRs, which is efficient for patient care but which also offers the possibility to longitudinally monitor a patient population (Van der Lei et al., 1993). This has many advantages that were nonexistent in the era of paper-based patient records. Such a system has numerous advantages, for instance, the possibility to monitor patients with chronic diseases, keep track of the often multiple medications taken by elderly persons, and assess the effect of the intake of drugs on the population. Several research projects have also been conducted to use such longitudinal databases to assess the quality of care. Such a project involving primary care patient data, called IPCI, for integrated primary care information, was started in our institute more than 10 years ago. An outline of this project is provided in Fig. 4. One research project in this framework involves the retrospective study of medications, known as postmarketing surveillance of drugs (Vlug et al., 1999).

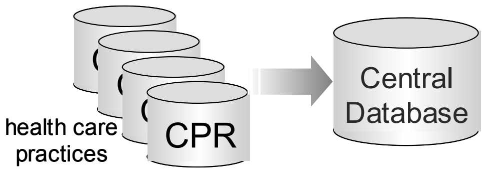

Figure 4. Outline of the IPCI project. Computer-based record systems in primary care deliver the data that collected longitudinally in a central

A sensitive element in such longitudinal studies is the privacy and security of both patients and physicians. Although all data on patients and physicians are anonymous, it is sometimes necessary to trace the individual patient, for instance, when in the framework of the study serious drug interactions or contraindications are detected. Therefore, measures were taken whereby patient data are first sent to a trusted third party, also a physician, who ensures that the data are made anonymous before they are stored in a central database. The key for coupling the anonymous patient data with the individual patient is under his custody. Furthermore, a supervisory board, consisting of representatives of the participating physicians, must give written permission for every study to be conducted. Several studies have been performed as part of the IPCI project to study possible adverse reactions to drugs (e.g., see the work presented elsewhere: (Visser et al., 1996; Van der Linden et al., 1998)). At present, the IPCI project database contains longitudinal information on more than 500,000 patients, and the intention is for the database to grow data to information on more than 1 million patients. The database is truly a treasure trove for population-based studies, which cannot be conducted with paper records.

The disadvantage of the retrospective use of databases with data that are collected as part of routine clinical care is that the data most frequently have been entered by clinicians who did not always follow the formal rules for data collection to ensure reliability and completeness. This is why researchers are a bit reluctant to use data retrospectively. For that reason we have conducted research to assess whether we could arrive at the same conclusions with routinely collected data. Fortunately, in the IPCI project this appeared to be the case. This is very advantageous, because the cost of a prospective study is generally much higher than the cost of using data collected as part of routine patient care. Nevertheless, when one intends to test certain scientific hypotheses, e.g., about the relationship between genetic characteristics in a population and diseases occurring later in life, the best method is to conduct prospective population-based research. We give three examples of the latter.

Prospective research

In our university, the Netherlands Institute of Health Sciences (NIHES), which comprises several departments in Erasmus University Medical Centre (Erasmus MC) and centres elsewhere in the Netherlands, is heavily involved in prospective studies, with most of these studies often involving data from large longitudinal databases. The key of all such studies is to collect relevant and reliable data from patients and healthy individuals and to store them in well-documented databases, which can grow to data on many thousands of patients. Data for several such databases have been collected over the years. Here we describe the databases for three projects: the Rotterdam Study, the Generation R study, and the GRIP (Genetic Research in Populations) framework.

The Rotterdam Study. In this study, data have been collected on about 10,000 individuals who were aged 55 years or older when they entered the study in 1990. Research is directed towards the study of diseases commonly found in the elderly: cardiovascular diseases, such as atherosclerotic vessel wall abnormalities; locomotor diseases, such as osteoporosis; neurological diseases, such as Parkinson's and Alzheimer's diseases; and ophthalmologic diseases, such as glaucoma. This research from the Rotterdam Study has provided new insights into diseases that commonly occur at older ages, and many new relationships between risks and diseases have been detected. Hundreds of articles and a host of PhD theses have been published on the basis of this research (Engelhart et al, 2002; Gaspoz et al, 2002; Hollander et al, 2002; Vaessen et al, 2002).

Generation R Study. Another large longitudinal database containing data that have been collected by research groups in NIHES concerns the other end of the age spectrum: the very young. Once a woman in the city of Rotterdam realizes that she is pregnant and visits a midwife or her GP, she is invited to participate in the Generation R study, which follows the children longitudinally until they are adults. The intent of the study is to collect genetic, physical, medical, and mental health data on these children, as well as information on the environments in which they grow up, to answer a host of research questions about the relationships between genetic and environmental data, the occurrence of diseases later in life, and the children's well-being. Such questions may pertain, for instance, to the effects of perinatal circumstances and diseases at a young age on health later in life, the consequences of differences in cultural backgrounds, and the impact of education. The study is being conducted by a large multidisciplinary team, consisting of researchers in biomedicine and the health sciences, as well as in psychology, sociology, and several other disciplines. A study like the Generation R study is unique in the world, in that it longitudinally follows a population from the prenatal period onwards.

Genetic Research in Populations. There is increasing interest in large-scale studies within the field of genetic research. For genetic research, the relatives of those who have been affected by genetic diseases and syndromes are the most valuable. In the Netherlands and elsewhere in Europe, there are various populations for which the genealogy, the relationship between inhabitants, is known from municipal or church records. Combining this information with data on populations with a certain disease will yield an incredibly powerful tool for gene discovery. At Erasmus MC, the Genetic Research in Populations (GRIP) study was started to couple the valuable information in clinical databases with those in genealogical databases. This study is conducted with a population in the southwest of the Netherlands, which in the past lived in relative isolation. As part of GRIP, several complex genetic disorders were studied. By using municipal records and genealogical databases with data on this isolated population of 20,000 residents, most patients with a particular disorder could be linked to a common ancestor. Analysis of this population has been shown to be extremely suitable for finding the genes involved in these disorders. This includes genes involved in hemochromatosis, (Njajou et al., 2001), type 1 and type 2 diabetes, Parkinson's disease (Van Duijn et al., 2001; Bonifati et al., 2003), and Alzheimer's disease. The project has been so successful that it has been extended into the Erasmus Rucphen Family (ERF) study.

The Erasmus Rucphen Family study includes 2,500 relatives from a genetically isolated population who have characteristics for early risk factors associated with several common disorders, including cardiovascular disease, depression, and ophthalmologic and endocrine disorders. The hypothesis is that by targeting the genes involved in the early pathology of disease, one will be able to understand better the early pathogenesis of these diseases in the future. This will improve the opportunities for successful prevention and therapy. The 2,500 subjects in the ERF study basically consist of 100 families of three generations whose ancestors go back to 30 founding couples who lived in isolation from 1850 to 1900. A part of the pedigree is given in Fig. 5. The presence of multiple loops in the pedigrees opens the opportunity for homozygosity mapping, i.e., finding recessive forms of a disease, which are the result of mutations in the two copies of the genes causing the disease. However, given the distance between the subjects, association studies can also be done, in which the genetic makeups of a series of patients and controls can be compared. As these subjects are all related to each other, genes can be identified by using a coarse set of markers.

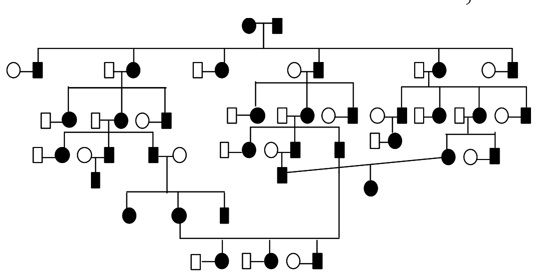

Figure 5. Part of pedigree mapping in the ERF study. The existence of multiple loops enables homozygozity mapping for finding recessive forms of diseases.

In all three prospective studies, 'soft' data from patient and participant interviews are not the only data that are collected. These studies also collect 'hard' data, such as the findings from ECGs, blood pressure readings, echocardiograms, X-rays, and computed tomography scans, as well as the results of chemical and genetic tests. Prospective studies in biomedicine therefore bear the characteristics of research studies in both the hard and the soft sciences. Prospective studies are also similar in a way to those that analyse the refereed scientific literature: it is possible to test the databases in a 'forward' way by using well-formulated hypotheses, but it is also wise to remain open for surprises and unexpected findings and to approach the databases with the attitude of being open to serendipity. As we stated above, in science it is important to have an open mind when one is evaluating research findings, so that one may say, '*Hey, that's strange!*'

Concluding remarks

Observations are most frequently quantified in modern science; that is, they are expressed as numbers or codes. This applies both to the hard scientific disciplines and the mathematics-based disciplines, such as physics, chemistry, and engineering, and to the softer scientific disciplines, such as the humanities. A special category of data consists of scientific texts, which are documented in refereed publications that ideally use the formal terminology of a specific discipline. All data, that is, numbers, coded information, signals, images, or measurements, are stored in computers for subsequent analysis and interpretation. Because the analysis of data with computers always requires a formal approach, analysis with models and algorithms is extremely valuable when one wants to test hypotheses derived from earlier research. This paper has provided some examples of these models and algorithms and how they can be used in scientific research not only to help researchers stay abreast of the latest findings in their fields but also to help researchers improve patient care and health and obtain new scientific knowledge from large databases of measurements, observations, and interpretations. The examples are representative for many other areas of scientific research.

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Growing Anti-intellectualism in Europe: A Menace to Science*

Pieter J.D. Drenth

Until a not too distant past science, as it was fashioned in the seventeenth century, enjoyed an almost matter-of-course reverence. Especially the achievements of mathematical physics and experimental medicine were accorded general respect and admiration. There was little doubt that sooner or later all secrets of nature would be unlocked and that life expectancy as well as quality of life would ameliorate markedly as a result of scientific developments. This was particularly the case since scientists, in the spirit of Bacon and Leibniz, tried to transfer some of their findings into practical technological applications.

At the end of the 20th century we see a notable swing-over of opinion. Science is not taken for granted any longer. Too often we note that the wide spread public appreciation has been replaced by doubts, scepticism or even enmity. Certain media, in which admiration and respect for science used to be preponderant, give utterance to misgivings, disillusionment or even anger nowadays. In those media numerous pseudo-scientific gurus are given a wide berth to give expression to their anti-intellectual and anti-scientific sentiments, and are believed by hordes faithful followers.

Partly these negative sentiments are dictated by the fact that science has eradicated much of what was dear to people: their pre-opinions, their prejudices, their spouse theories, but also their world view or sometimes even their faith. Science has robbed humanity, as Shea (1989) rightly elucidates, of many of its illusions. Copernicus and Gallileo deprived the earth of its position at the centre of the universe, Darwin denied the singular nature of the human species, Freud suggested that a human being has neither insight in nor control over his deepest motives and drives, biochemists have reduced the miracle of life to chemical processes and geneticists showed that the fusion of

* Some of the thoughts expressed in this article were formulated earlier in a paper presented at the 10th European Sceptics Congress in Prague, 7-9 September 2001.

male and female gametes is no longer a prerequisite for human procreation.

Many of these negative attitudes and sentiments are fed, in part, also by fear; fear for lack of control over the possible effects of scientific developments: nuclear waste, environmental deprivation, horrific consequences of genetic modification, arising dangerous viruses and bacteria, loss of liberty and privacy through ICT developments, fear, perhaps also, for a dominant scienticism and secularisation, and deprivation of religion and spirituality as its consequences.

Not all criticism is objectionable. Some of the captious questions posed to the present day scientists are agreeable to reason and need careful attention. The question arises whether *Homo Sapiens et Sciens*, who has appropriated much of the divine power of the time, is sufficiently capable of handling that power in a responsible manner. Are scientists always aware of the potential and ethical consequences of their research? Do they fully realise that others, such as politicians, managers, investors, clients and ideologists may have an interest in the outcome of their research? Are scientific practitioners capable of dealing judiciously with the new-found knowledge? Have scientists sufficiently freed themselves of unwanted intrusion of influence? Have they protected research subjects against the infliction of unacceptable harm and exposure to unacceptable risks? Questions and criticisms like this cannot be arrogantly ignored by science. If not given serious attention they may erode the axiomatic quality of science and even pose a threat to science as an intellectual endeavour (Elkana, 1989). Moreover, since these attitudes may influence the general public, they may also have an unfortunate effect on the willingness of the political leaders to reserve the necessary funds for innovative and frontier research.

In other words, public opinion, the sentiments of voters and the bias of the media debate largely determine the boundaries imposed on scientific practice at the beginning of the 21st century. And, as we have seen, these sentiments are unmistakably more sceptical and negative than in the past. It seems prudent, therefore, to take a moment for a closer examination of this critical attitude of the public and the media.

Public scepticism and criticism

We may distinguish three forms of opposition or criticism in discussing society's critical attitudes towards science: anti-science, para-science and pseudo-science.

Anti-science is the most negative. It goes beyond claiming that science has failed to produce any salutary results or benefits, holding instead that it is the root of much trouble and a catalyst for disaster. In this view science is held responsible for gross inequalities in wealth and poverty in the world, for global pollution, for amoral consumerism, for giving rise to new diseases and genetic aberrations, and it is seen as a threat to economic balance, international justice and peace. Science painted as the villain of the piece. References are made to Lombroso, Mengele and the eugenetic movement, deterrent stories are told (and with pictures illustrated) about headless froggs and mice with human ears, and about a world with an unimpeded practice of human cloning. In these stories the scientist is often depicted as an irresponsible and ruthless Mephisto or Frankenstein.

A long time science has brushed aside these anti-science sentiments as products of frustration or irrational anxiety. But since these anti-science noises can be heard more frequently nowadays, and from time to time are mixed with justified questions on the social and ethical responsibilities of the scientist, such a neglect may be harmful for integer science indeed.

Less directly aggressive towards science but in the long run equally dangerous are the effects of these sceptical attitudes on the development of a large variety of para- and pseudo-scientific theories and approaches. Particularly the sciences that deal with very personal and existential needs (well-being, health, understanding), including medicine, psychiatry and psychology, have been a victim of such deviations from the classical, accepted scientific traditions. In the following we will pay special attention to the para- and pseudo-scientific excrescencies in the behavioural sciences, but we are convinced that much of the reasoning given in this context is generalisable to many other disciplines as well.

Para-science is not in itself anti-scientific, but claims that scientific knowledge is insufficient for proper and full insight in human behaviour, and that additional paths have to be walked for its real understanding. Since science is not expected to amount too much, a plethora of alternative solutions are offered, including esoteric methods, psychic media, telepathy, listening to voices for instance from space, clairvoyance, tarot reading and others. The therapies or treatments connected with these approaches often flirt with equally esoteric, occult or paranormal practices: faith healing, reincarnation, healing by laying hands on a patient, hypnosis and others. Often these methods are but one small step away from the spoon benders, horse whisperers and fingertip surgeons. The line between genuine ignorance and fraud is often terribly vague.

We are not speaking of a rarity in the present New Age era. A number of para-scientific beliefs and movements have accumulated a fairly sizeable following. A survey among Newsweek readers a few years ago revealed that almost 50% of the respondents believed in the existence of UFO’s, and that some 30% believed in the existence of aliens. A more modest survey among students at my own university some years ago revealed that one third trusted that memories of past lives can be triggered under hypnosis, that two thirds accepted the predictive value of dreams, and that a quarter believed in psychokinesis. And since the collapse of the Communist ideology in Central and Eastern Europe the popularity of para-science there is raising alarmingly. Is it that the abjuration of the repressive regime has opened the door for a false conception of freedom, in the sense that 'everything goes' and that rational discipline is no longer needful?

One may wonder why and how these unlikely and illogical views and claims so often are accepted and believed. Evidence and arguments for the contrary do not seem to have much effect. Even remarkable testimonies to the harmfulness of some of these ideas and practices do not undermine the maintenance of these beliefs. Dawes (2001) has made an interesting distinction in this respect. Lack of supporting evidence, even evidence for the opposite or outright contradictions are only important for people that (like to) think coherently and rationally, which takes time and effort. Unfortunately many people think in the intuitive mode, which is swift, effortless and associative. This is then further reinforced by five of the 'seven sins of memory' (Schacter, 2001), transience (forgetting things), misattribution (mixing aspects of memory), suggestibility, bias and persistency (perseverant memories of traumatic events). Dawes believes in educating people to become more rational thinkers, since he is convinced that the world would be a better place if we made the effort to think rationally and coherently.

Pseudo-science looks somewhat like para-science, but distinguishes itself by the intention to appear scientific. Pseudo-scientists flirt with scientific terms and concepts, write articles and books in a scientific fashion and with a scientific pretention, and suggest that they want to take part in the scientific debate. Often they have special training schools or give special courses, they award titles and certificates to their graduates, albeit outside mainstream academia.

Behavioural pseudo-science

Three types of pseudo-scientific manifestations in behavioural sciences can be distinguished: Pseudo-scientific theories, pseudo-scientific diagnostics, and pseudo-scientific treatment/therapy. In the following we will pay some attention and give some examples of all three types of behavioural pseudo-science (part of the following has been discussed also in Drenth, 1999).

Pseudo-scientific theories
Pseudo-scientific theories consist of sometimes very elaborate conceptual constructions, but often built upon one or two basic assumptions or beliefs that are unverifiable: belief in reincarnation (reincarnationism), belief in the existence of aliens, angels or devils, or a personal God that influence human behaviour and affect destinies (theories adhered in certain sects or religions), the influence of the positions of stars and planets at the very moment of birth (astrology), the idea that mental power can influence the location and movement of physical objects or processes (psychokinesis), or the idea that simultaneous developments in quite different areas can be explained as expressions of one common principle (metabletica). Some of these theories are fantastic and imaginary, sometimes bizarre and eccentric, often also fascinating and gripping, as Van Boxsel (2001) demonstrates in what he describes as morosophy (foolish wisdom, or wise foolishness). Some of these theories go way out, such as the world peace mathematics, the pneumatic-energetic monism, interastral communism, spiritual intelligence, and the theory of Bach-numbers.

Others are less harmless, since they are used to explain, predict and control human behaviour. Reincarnationism and astrology are certainly among the most well known examples of these dangerous convictions.

Such theories, however, are always scientifically delusive, since they are basically unfalsifiable. Again, in the case of exotic morosophic fictions no harm is done; it is even an intellectual challenge to try to counteract some of the sometimes ingenious argumentations. But in case these theories are used as a basis for psychological explanation and are applied to influence people and to affect their lives, the situation is different, and it is here that the unfalsifiable assumptions come home to roost. Of course, one can try to falsify some of the predictions made on the basis of the theory (which has been done for example with respect to reincarnationism, and astrology), but falsification is never accepted as disqualification of the theoretical presuppositions. Invalidating evidence is always explained in terms of measurement faults, sampling errors or predominance of other factors in the complex system of behavioural determinants. It is never the default of the theory. This is why it is always a discouraging endeavor to get engaged in a scientific debate with defenders of these theories. They always flutter away and evade the real argumentation.

Pseudo-scientific diagnosis.
Here we are at the territory of fictitious psychodiagnostic analyses of human behaviour. And the examples in psychology are abundant. A great many invalid and defective instruments and methods have been and are used in a non-professional context, and, unfortunately, in professional psychological practices as well. But we have to make a distinction between psychodiagnostic applications that *do not meet* the generally received psychometric standards and *pseudo-scientific* psychodiagnostics.

The first category refers to practices in which tests or other diagnostic instruments are used that have not demonstrated satisfactory reliability and validity, both prerequisites for responsible application. In an adequately reliable test the results are not influenced too much by chance factors; the test is a sufficiently consistent measuring staff. A test is sufficiently valid if there is enough empirical evidence for two claims: firstly that it measures the capacity or personality trait which it is supposed to measure (construct validity), and secondly that it predicts with reasonably certainty future performance or behaviour of the tested individual (predictive validity). Unfortunately too many instruments and tests are used for descriptive or predictive purposes without measuring up to these two criteria. Personality questionnaires and scales, interviews, performance tests, lie detectors, observation tests, even regular intelligence and achievement tests are used without sufficient warrant that the psychometric and validity standards have been met. But this should not be considered as pseudo-scientific diagnosis, rather as substandard performance of psychologists. Both psychometric amelioration of the instruments and better training and increased responsibility of test users could lead to an improvement of this malpractice.

Pseudo-scientific diagnosis makes use of diagnostic instruments or methods that suffer from principal defects or shortcomings, that are based on unscientific, erroneous or sometimes even preposterous presumptions. Some of them were once popular, but are not taken seriously any longer. Examples are the Szonditest, Koch's Baumtest, the Pfister colour pyramid test, Lüsher's Colour test, frenology. Others are incidental trials, one-day flies, or eccentric beliefs outside the mainstream (e.g. Penn colour system, naildiagnostics or the Figure Preference Test). Again others, just as ludicrous as the tests listed above, are still used widely. Examples are the Rorschach Inkblot test, Draw a Person (DAP) and other expression techniques, among which in particular graphology, still popular among others in Germany, Israel, France, Switzerland, and parts of the USA.

Time will not permit me to demonstrate the unscientific basis of these tests and projective techniques, and the reader has to be referred to the critical literature on these instruments (Jackson & Messick, 1967; Drenth & Sijtsma, 1990). But I may bring to the fore graphology as a prototype of the pseudo-scientific diagnostic methodology.

Graphology is distinct from *handwriting-expertise*. The latter is a method to compare pieces of written text in order to establish identity or non-identity of the writers, and which has an accepted evidential value in court. Graphology starts from the assumption that given characteristics of handwriting can be identified reliably and have diagnostic meaning if properly interpreted. Graphology is therefore a putative method of personality assessment. In that sense it can be compared with and falls under the same scientific rules as other assessment measures. But it is here that graphologists and experimental psychologists diverge. Repeatedly it has been shown that graphology cannot substantiate its claims, and that its predictions about human behaviour and performance are so little different from chance distributions that its use as selection-instrument or as psychodiagnosticum is certainly not warranted (see for instance Jansen, 1974). But graphologists ignore these conclusions, base their claims on personal experience, on casuistry, on analogy argumentations (large writing: a person with grandeur, angular writing: abrupt manners), on generalizations of impressions (sloppy writing indicates a chaotic personality, 'controlled' and tight writing refers to a rigid, constricted, possibly even compulsory personality), or on reference to an in those circles authoritative school of thought, which has been powerful, but lacks any empirical test or validation. Particularly the German characterologist Klages has been influential in this respect with his theory about the opposition of the cognitive mind and the feeling heart (*der Geist als Widersache der Seele*). Any expression (also in handwriting) is a reflection of the balance between these two powers and the diagnostician has to disentangle the underlying forces. In another leading school of thought the Swiss graphologist Pulver propagates the use of space symbolism. The top zone in written letters represents the intellectual and transcendent spheres, the middle zone the personal, regulating forces, and the lower zone the animal, material nature. The (emphasis on the) left reflects the past, the ego, the introvert side, and the (emphasis on the) right the other, the future and the extravert part. Look here, the elements for an imaginative interpretation are on hand.

What makes this diagnostic tradition pseudo-scientific is the lack of experimental verification, even the lack of the need for such scientific control on the one hand, but extensive flirtations with psychological and philosophical theories and traditions and a quasi-scientific packing of the message on the other.

Pseudo-scientific treatment and therapy

In the therapeutic garden a host of pseudo-scientific horsefeathers can be found, ranging from hypnosis to healing by prayer, from reincarnation therapy to scientology, and from neuro-emotional integration to homeopathy. Again, time does not permit us to give a full and critical account of all these therapeutic approaches. Moreover, since time and again new therapeutic movements come to the fore, it is difficult to keep full record of these developments.

But in our analysis we have to be careful. Unlike diagnosis, prediction of human performance or behaviour, and assessment, therapy is not a (applied) scientific activity. Criterion for therapeutic activity is effectiveness, not verity; at stake is not whether it is true, but whether it works. We all know that credibleness of the therapist and faith being put in the therapist are equally or sometimes more important than the quality of the treatment or the medicine as such. We also know that placebos work if brought with cogency and that spiritual healing or a magic word of an overbearing guru may cure even somatic diseases.

This is not to say that these types of healing are not without danger. In the first place we see often a more serious relapse after a temporary improvement, as was shown by the psychologist Vervaet in a follow-up study of patients healed by praying. Moreover, in case of no or little success victims suffer not only from feelings of disappointment but also from feelings of guilt and failure (insufficient motivation of faith). Third it prohibits serious investigation and diagnostics with once and again tragic consequences.

But what brings some of these therapeutic approaches into the category of pseudo-science is the claim that their presumptions are predicated on scientific understanding and scientific evidence. Often we see that these therapies are presented and justified by such scientific pretensions. Again, I will illustrate this by discussing a fairly recent and popular movement known by the name NLP, an acronym which stands for neuro-linguistic programming (see also Drenth, 1999). NLP was presented by Bandler and Grindler in their *Frogs into Princes* (1979), and elaborated for instance in Adler's *The New Art and Science of Getting What You Want* (1994). The 'edifice' is grounded on a few truisms: emotions and motivations affect the body ('neuro'), people often mean something different from what they say ('linguistic'), and setting a goal and believing in it helps achieving this goal ('programming'). Then they take off. With rich phantasy concepts and relationships are introduced (engrammes, nominations, perception types) and conclusions drawn (on emotions, on creativity, on left or right brain dominance) which lack each theoretical or experimental basis. The psycholinguist Levelt (1995) passed devastating judgment on NLP: It is not informed about the literature, it starts from insights that have been rendered out of date long ago, concepts are not apprehended or are a mere fabrication, conclusions are based upon wrong presumptions. NLP theory and practice have nothing to do with neuroscientific insights, nor with linguistics, nor with informatics and theory of programming. NLP is not interested in the question as to how neurological processes take place, neither in serious research.

The question raises: Why is it still so popular? Why do people pay for the expensive courses and consulting? Why its popularity in (even respected) companies, as well as in educational and orthopedagogical circles? In the first place it is a shrewd commercial formula and marketing. Then there are the flirtations with science (the name NLP, the 'masters degrees', the 'scientific' books). But as soon as NLP is seriously challenged scientifically we see sham manoeuvres: “we are interested in another kind of truth”, “something can be true even without scientific proof”, “it is self evident”, “clients are happy and satisfied”. With these argumentations swindle is defended and people are made to believe that the moon is made of green cheese. *Mundus vult decipi, ergo decipiatur.*

Why psychology?

Finally, an interesting question is: why is pseudo-scientific moonshine so popular notably in psychology and psychiatry? Let me briefly offer a few suggestions:

1. Pseudo-scientific psychology hitches into the (sometimes desperate) need of people with psychological problems: neurotic, anxious, depressive, or phobic patients, that are despondent at the end of regular and unsuccessful treatments, often take anything for granted.
2. Confusion of object and method. Psychology deals with phenomena that are often not (yet) understood and cannot (yet) be explained: dreams, phantasies, anxieties, déja-vu’s, telepathic experiences and others. One is too easily persuaded to accept that these phenomena can never be clarified via normal scientific reasoning, and that 'new' and 'creative' methods are needed.
3. Pseudo-scientific movements often make use of social psychological mechanisms, such as the need for belonging, group think, ingroup – outgroup controversy. Critics are silenced with the retort that one must be part of the movement to make a sound judgment. Lack of criticism is further enhanced by features

reminiscent of new religions: gurus, rituals, incantations, and inaccessibility.

4. Founding theories and visions were once popular and accepted, but new scientific research has demonstrated their untenability; however, adepts still cherish the idols and adhere the outdated ideas. This may explain the tenacity of the conjectures about the relationship between physical and mental characteristics, location of capacities and traits in the brains, Jung's typology, the temperament cube of Heymans, the inkblot method of Rorschach, and many other illusions that are for instance described in Kouwer (1963).
5. Economic motives. Often pseudo-scientific practices are motivated by loathsome pursuit of gain. We have already seen the economic manipulation of the credulity of NLP-quarries. Graphologists offer their services to organizations and individuals, and quite a few of them are making a good living. Well known is the financial exploitation of the victims of scientology, avantar and similar movements: *mundus vult decipi*, even if - or, paradoxically, because - it requires financial sacrifices.

A final word

Whatever its causes, there is no doubt that the pseudo-scientific fiction in psychology and psychiatry is able to develop and flourish in the room created by the anti-scientific sentiments of the present *Zeitgeist.* The dwindling appreciation of science should, therefore, be a major concern for scientists and scientific institutions at the beginning of the 21st century.

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Science: Does it Matter?*

Pieter J.D. Drenth

According to Dixy Lee Ray the general public has long been divided into two parts: those who think science can do anything, and those who are afraid it will. Apart from the totally diverging appreciation of its effects, this statement suggests that in fact all of us react affirmatively to the question: Does science matter?

In a more serious vein, affirmative answers to this question can also be heard from responsible official sources: 'Relevant science' is one of the corner stones of European Commissioner Busquin's successful plea for a European Research Area. The UK's Prime Minister Blair acknowledged the importance of science for the future of his country in a speech at the Royal Society last year (23-5-02). On 20 January this year, the Irish Deputy Prime Minister Harney stated: "In today's economy, neither natural resources, cheap labour, nor capital stock are as important to the national competitive advantage as innovation built on new ideas and new knowledge." Recently one of the governors of the French CNRS, Henri Audier, warned in Le Monde (08-04-03) that if Europe wants to preserve its role in the world of tomorrow "il est grand temps de fixer comme priorité l'education, la formation, la culture et la recherche". The power of a nation, wrote the Nobel laureate Francois Jacob in the same issue of Le Monde, was long measured by that of its army. Today, he continued, "elle s'évalue plutôt à son potentiel scientifique." These and many other officials all stressed the importance of science for our economic and social future; in other words, they stressed the relevance of science.

Of course, the discussion on the relevance of (natural, social and human) sciences is not new. It has been the subject of extensive discussions in the Western world during past decades, especially since the neo-Marxist ideologists in the 70s propagated that relevance was equal to the extent to which sciences contributed to the emancipation of the lower classes and to the general ideals of equality and a free and democratic society. Much of the more recent political debate on the

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appropriateness of scientific research is rooted in a quite different, and equally narrow, definition of relevance, namely as the contribution to industrial and economic growth and development. There is also relevance as seen through the eye of the technologist who sees the relevance of science in simple instrumental terms: the extent to which it furthers the availability of valid and useful instruments for practical application. Clearly, the relevance and usefulness of science refer to diverging goals and contexts, and will be defined differently by various users.

Types of relevance

It may be appropriate to elaborate on this concept of relevance. I propose a distinction between four types of relevance:

In the first place there is *intrinsic* relevance, which goes beyond economic value and practical applicability. Research, be it in the natural sciences, in the humanities or in the social sciences, leads to an augmentation of the body of knowledge, an intrinsically valuable and precious quality of civilisation. Raising questions on the nature and determinants of observed phenomena is a fundamental and unique characteristic of the human species and a motor for its development.

It is clear that the continuity of this scientific discourse appears to its full advantage in a dialogue with the next generation. In other words, intrinsic relevance is strongly related to the educational mission of science: the transmission, revalidation and further development of scientific knowledge in training and education, and in the enrichment of the next generation with knowledge and insight.

It can be argued that this educational function has an even broader dimension: intolerance, enmity, discrimination, xenophobia, and ethnic conflicts are often products of ignorance. Therefore the educational function also pertains to the broader community; the scientific enlightenment of the general public can be regarded as an important instrument with which to develop and strengthen the intellectual defensibility and democratic foundation of a society.

Secondly there is *instrumental* relevance, the immediate or indirect application of research through the transformation of its findings into practical tools and instruments. It cannot be denied that science has had and still has a tremendous instrumental relevance. There is no sphere or dimension in our personal and social life that is not fundamentally affected by technology resulting from scientific research.

In the third place there is *innovative* relevance. This type of relevance refers to the contribution which scientific research can make to the creation of new knowledge and insights, which may lead to important breakthroughs in the development of industrial products, health measures, transport, communication, entertainment, and many other applications.

It should be emphasised that, while instrumental relevance is often a product of what is called applied or problem-driven research, this does not always have to be the case with respect to innovative relevance. Also pure, 'curiosity driven' research may turn out - sometimes unexpectedly and unintentionally, and even many years later - to be highly applicable. The application of polymer chemistry in plastics manufacture occurred more than 30 years after its formulation, the time lag between the development of Marconi's telegraph and Maxwell's groundwork on the transmission of electronic waves was more than 25 years. Many present day cardio-vascular surgical or pharmaceutical interventions result from the fundamental research of decades ago. Whatever the case, this observation justifies the importance of both applied and pure research.

The fourth form of relevance can be called *contributive* relevance. Here the aim is not instrument development or technological innovation, but rather to support or to contribute to decision-making and policy development. This can take place in the various phases of decision-making: problem definition, search for alternatives, finalisation, and implementation. The role of science is more explicit if scientific insights or research results clearly contribute to a change or continuation in policy, or if the research results are used as *ammunition* in a discussion or debate, either to defend or to attack a certain position or to create positive or negative attitudes with respect to a certain stance or view. The role of the scientist is rather disguised in cases where (s)he is actually one of the partners in the decision-making or policy-formation process (the interactive model). The question of which role scientific insights play in the complicated and sometimes chaotic interplay of rational and irrational forces is difficult to answer. Often these insights are used for what is called *conceptualisation*: redefinition of the agenda, sensitisation of decision-makers with respect to certain problems, the (re)definition of problems, or the transformation of problems into non-problems.

If relevance, as is expounded in the above, is seen as a complex and multidimensional concept, any attempt to develop unidimensional measures for this relevance is doomed to failure. The European Commission's task to assess the socio-economic relevance and impact of the research it sponsors is not only unenviable (Research Europe, 06-03-03), but will also inevitably lead to restricted results. Monitoring tools for assessing the socio-economic effects of science, or for measuring concrete results (submitted or granted patents, spin-offs in the form of new companies, industrial growth etc.), however useful, will only reveal part of the tale. It is important to keep this restriction in mind.

Two types of knowledge

As has become apparent in the discussion above, the roles of the scientist and the decision-maker are not always clearly distinguishable. Nevertheless, it may be wise to keep the ideal division of roles in mind. Researchers may generate information on feasibilities and impossibilities, chances and risks, direct and indirect repercussions, they can denounce stereotypes and prejudices, they can show that certain fears have no scientific or statistical justification, but they can never bear responsibility for the actual decision. They can provide evidence for the relationship between performance-related remuneration and work motivation, but they are not responsible for the level and nature of collective agreements. They can point to the evident negative relationship between smoking and health, but they are not responsible for anti-smoking legislation and rules. They can analyse the positive and negative effects of nuclear energy, but they are not held responsible for a decision to close nuclear power stations. Their trade, in short, is science and that is what they should stick to. They should not become another pressure group or seize the responsibility of politicians, employers, doctors, legislators, and educators. It would give power to a group who is neither trained nor competent to exert it.

But there is another complicating factor. And this has to do with the nature of knowledge and the soundness of the research on which the scientist's input is based. A distinction can be made between two sorts of contributions, depending on two disparate types of scientific knowledge:

In the first place there is *solid* knowledge, which is often the product of long and painstaking experimental or empirical research, and which is hardly ever the subject of disagreement and debate among scientists. We know of the effects of ultraviolet radiation on health and environment. We know of the damage that chlorofluorocarbons and carbon dioxide effluxes cause to the ozone layer. We know of the causal relationship between smoking and cardiovascular diseases and cancer. We know of the interaction between anxiety and motivation, of the negative effects of group thinking - all examples of solid relevant knowledge. Many more examples can be given. I am not saying that utilisation is a simple matter, but the knowledge is available and only needs political transformation for use in policy decisions.

A second type of knowledge is *probabilistic*; it is less solid, uncertain and incomplete, and direct extrapolations are risky. Think of the prediction of a successful career, of expected returns on investments on the stock market, of the effects of atmospheric changes on the biosphere, of the long-term effects of genetic modification of plants and animals, of the strength of cultural resistance against fertility control. Numerous other examples can be given. With respect to many and often pressing questions and problems in society, our knowledge is of such nature: probabilistic, uncertain and contingent, due to either ontic (really existing in the world out there) or epistemic (insufficient and lacking knowledge) uncertainties or both. And it would be a serious mistake to communicate this 'probabilistic' knowledge to the public and to policy makers as if we were certain of the insights and conclusions. We see the negative effects if we do: confusion and suspicion at the expense of scientific research's credibility.

There is one aspect, however, that is shared by all types of knowledge and that is also a precondition for its usefulness for policy and decision-making, and that is its *independent nature*. The emperor Justinian did not realise that he had cut off a vital source of political life when he closed Plato's Akademeia a millennium after its founding, because its views were not in line with his own. George Bush's administration (in line with successive US administrations) does not realise how much it wrongs itself by packing advisory committees with scientists and other experts who share the administration's political outlook and have become 'all the President's yes-men'. The current US administration has so politicised the provision of scientific advice that it could permanently undermine public trust (Nature, 30-01-03). We are dealing here with an essential prerequisite for the relevance of science. Without this independence and freedom, science will sooner or later become irrelevant and useless.

Non-use

One of the major frustrations of the scientists is that his/her research results are not given proper attention. RTD info (October 2002, no. 35) sounds a note of disappointment regarding the relative sidelining of science during the Earth Summit in Johannesburg last year. "The scientists may have been heard but they were not really listened to. Some of the political speeches ignored or even contradicted the 'facts' now supported by an accumulating mass of evidence". The UK National Audit Office recently concluded "much of the £1.4 billion that the government spends on research each year is wasted". The chairman of the House of Commons' Public Accounts Committee pours oil on the fire by responding to the report with "research is no use at all if the policy makers do not know about it, do not understand it or need something else".

Why is scientific knowledge often ignored or neglected by politicians and decision-makers? Briefly the following reasons and motives can be brought to the fore:

A first reason is that the research result is not believed or accepted because it is contra-intuitive or contradicts stereotypes or popular prejudices; the theoretical impossibility of the effects of homeopathy, the default of attempts to infer personality traits from handwriting, the failure to find empirical or experimental evidence for astrology, the inaccuracy of many ethnic, geographic or gender stereotypes…. all these research results find it hard to replace the contrary, but persistent, prejudices.

Secondly, research repeatedly produces contradictory results: whether there is global warming or not, whether a certain drug or treatment helps or not, whether violence on television is harmful or not… research results are available in support of either point of view. Of course, we know that science in development generates inconclusive and even contradictory research results, and that the differences can often be explained in terms of different samples, circumstances, instruments or diverging research designs, the fact of the matter is that incompatible and inconclusive research results are often a motive for the public to ignore scientists.

In the third place, no or insufficient scientific knowledge is or has been made available in respect of many decisions. Sometimes no research has been carried out with respect to the problem in question. The scientist should be clear about this in his communication with the decision-maker. More often the results are as yet insufficiently conclusive to allow for solid advice to practitioners and politicians. To 'sell' unwarranted certainty is dangerous and may have a boomerang effect. Then we deal with probabilistic, contingent knowledge as described in the previous section. Feckless claims and unjustified certainty with respect to this type of knowledge will backfire as well. But users find it difficult to appreciate this type of imperfect knowledge and do not like the uncertainties that it implies.

A fourth and most alarming cause is the observation that the scientist does not provide answers to the policy maker's real questions. Too often his fragmented, detailed laboratory (type) studies are thought to contribute little to the understanding and handling of the complex and multifaceted reality which the decision-makers face. "Too often research and researchers seem to have little to offer on some of the key challenges we face in public policy", and "Typically research questions as defined by those outside academia are cross-cutting: rarely can any one discipline or practitioner address it successfully….", reported The Times Higher (28-03-03).

A fifth motive is not a lack of understanding, but a lack of willingness. Unwillingness to accept the results of research, since these contradict one's own preferences, ideological views or convictions. In extreme cases, the research itself is attacked or prohibited (Gallileo, Spinoza), and/or the researcher is forced to comply or killed (Lysenko, More). More often attempts are made to influence the research results by suborning or threatening the researcher (a real danger with industrial or governmental contract research). But a simpler solution is, of course, to neglect the research evidence.

A sixth reason stems from the irrefutable fact that political decision-making is more than the pure application of facts and knowledge. In a stable and comprehensive policy development and decision-making, values, norms, ethical and political considerations are important and legitimate elements in addition to the scientific and statistical facts and findings. This may assume an objectionable form if rationality is totally suppressed by power, negotiation, wheeling and dealing, personal ambitions and affinities, prospects of (re-)election, and the like. But it is, of course, perfectly justifiable to let normative, moral considerations determine an outcome that may deviate from ‘scientific predictions’. Lowering the selection norms in schools for immigrants, desisting from a planned investment in a country with a repressive regime (Burma), quota systems for minorities….such decisions are acceptable to the scientific advisor if the scientific extrapolations and probabilities have been acknowledged but (with adequate arguments) ‘overruled’.

A final word

Above it was argued that scientists who contribute evidence about the positive and/or negative effects of certain options should not bear the responsibility for the actual policy making and policy decisions. They are led by scientific criteria and veracity is their main touchstone. Freedom and independence are both an important sine qua non of scientific research.

This, however, does not mean that the scientist does not bear a moral and societal responsibility. Science must concede that it is embedded in a host of ethical, social and political issues and problems that cannot be dismissed as trivial or irrelevant. Scientific activities and results are subject to ethical and political norms which have a bearing on the choice of hypotheses, the gathering of data and the conducting of experiments, and on accountability for what is ultimately done with the research data. Scientists should be aware of the dangers involved in generating knowledge that may be used in applications over which society has little control. They should also take the apprehension of the public seriously. *Nature* (17-07-'03), for instance, is right in arguing that we should not make the same mistake and dismiss people’s fear of the harmful effects of nanoparticles as we made in respect of losing many countries’ trust in genetically modified food. The challenge for science (and academies of science) is therefore not so much the choice between freedom and responsibility, but rather the attempt to find a balance between, or even to unite these two seemingly irreconcilable objectives. Freedom, therefore, is freedom in constraint. Or as Shaw observed: “freedom means responsibility, and that is why most men dread it”.

Only the responsible scientist can restrain the earth from the “walk to the gallows” which Martin Rees macabrely depicts in his recent book “Our final century: will the human race survive the 21st century?” (Rees, 2003). And only the responsible scientist can denounce the cynical observation quoted in Weber (1982): The reason life is probably extinct on other planets is that their scientists were a little more advanced than ours. Let us assume this responsibility!

References:

Rees, M. (2003). *Our final century: Will the human race survive the twenty-first century?* London: Basic Books.

Weber, R.L. (1982). *Random walks in science, More random walks in science.* Bristol: Institute of Physics.

Recent Developments in European Science Policy: ALLEA's Point of View*

Pieter J.D. Drenth,

The subject of the international IAAS-symposium 'Basic research in the modern innovation process' is both propitious and timely. In many research organizations and governmental agencies that are dealing with science and research policy in Europe, not only at the national but also at the European level, the desired balance between basic and applied research, the relevance of fundamental science and its contribution to technological and economic developments is under discussion. In this paper we will touch upon a few of these discussions and elaborate each time on the position and contribution of ALLEA in this debate.

For information to those who might not be fully acquainted with ALLEA as organization the following: All European Academies is the European network of National Academies of Sciences and Humanities. It was created when new opportunities for cooperation arose in the 90s as a result of the end of the cold war, and in the context of the increasing significance of supra-national organizations and institutions in the area of science and higher education. At present it has 48 members (i.e. national Academies) from virtually all European countries from the Atlantic to the Urals.

European Research Area

In January 2000 the European Commissioner for Research, Philippe Busquin, launched an in the meantime well known and widely discussed grand idea: the European Research Area (ERA), a truly European vision on the promotion and furthering of research in Europe. ERA aims to develop a European-wide research policy of both national and European objectives and priorities. Major changes are introduced

* Presented at the conference "*Basic research in the modern innovation process*" in Kiev, Ukraine, December 2003.

by ERA as far as research management and funding are concerned. ERA was and is an ambitious plan that aspires to result in better coordination between the Commission and Member state research policies and more complementarity between European and national funding of research. In addition to the current Framework funding procedures and instruments some new policies for direct funding are introduced in the ERA, including (1) Networks of excellence on selected and well defined themes, (2) Large integrated projects with specific research objectives, (3) Participation in programmes carried out jointly by several EU-member states, and (4) Specific research activities for SME's and special international cooperative activities, that are carried out in order to anticipate the EU's scientific and technological needs.

The launching of the ERA-idea has initiated a lively debate in which a multitude of science policy makers and scientists participated. Countless reactions, comments, articles and critics have appeared in the press and the debate is still at full blast. Also the Commissioner has cast further light on his ideas in numerous talks, interviews and publications. One of these Communications, which is particularly relevant to the theme of the present conference, is 'More Research for Europe; towards 3% of GDP', published 11-09-'02. In this communication Busquin referred to the so called Lisbon declaration of the European Council (March 2000) in which the Heads of State set the objective "to become the most competitive and dynamic knowledge-based economy of the world, capable of sustainable economic growth with more and better jobs and greater social cohesion by 2010", and to the subsequent Barcelona European Council agreement in 2002 stating that "research and technological development investment in the EU must be increased with the aim of approaching 3% of GDP by 2010, up from 1.9% in 2000." "More attractive framework conditions are essential for Europe if it is to achieve this investment objective", the Communication continues. Among the most important suggestions are: a sufficient supply of highly qualified human resources, a strong public research base, a dynamic entrepreneurship culture, adequate systems of property rights, innovation friendly regulations, supportive financial markets, macro-economic stability and favourable fiscal conditions. It is further stated that actions should be launched at the European level, but also that more needs to be done to ensure that it is delivering results at national and local levels. At the same time – and this is an important addition by the Commissioner – it is recognised that the diversity of situations in Member States and Candidate Countries must allow for a ‘differentiated policy response’.

ALLEA has responded to this Communication with a letter, asserting the following points:

(1) ALLEA agrees with the view that the creation of a European Area of Research and Innovation is a key condition for the European Union to become a leading knowledge based economy in the world, and that the objective to raise the percentage of European GDP to be spent on R&D from the present 1.9% to 3% by the year 2010 is both ambitious and laudable.

(2) ALLEA is in agreement with the Commissioner when he suggests to allow for the rather large diversity that exists in the national and regional conditions both in terms of overall level of R&D investments and the balance government-business funding, and to plea for differentiated policies towards the 3% objective. It is in particular the candidate countries in which the share of the business funding remains very low. ALLEA would have appreciated a somewhat more specific elaboration of this differentiated policy, and the specific support which the Commission has in mind. In this connection reference is made to a recent report of a ALLEA-working group under the chairmanship of Prof. Jüri Engelbrecht, President of the Estonian Academy of Sciences (*National Strategies of Research in Smaller European Countries*, Amsterdam, ALLEA Report Series, no. 1), in which a number of recommendations and steps to be taken by policy-makers are suggested, in order to develop a strategy of research in smaller European countries. The recommendations include ensuring the quality of research, capitalising on the existing strengths, achieving an optimal balance between science-driven research and meeting society’s needs, stimulation of networking, mobility and (small scale) cooperation, strengthening the administration and improving the research infrastructures.

(3) ALLEA shares the Commissioner’s grave concern about the declining attractiveness of natural sciences and engineering among students and young researchers in many European nations, a tendency which is even aggravated by a growing net outflow of S&T human resources from Europe to the US. Great pains should be taken to stem this unfortunate development. According to ALLEA a variety of measures and strategies could be considered, including:

- The encouragement to develop and to implement programmes for raising interest in sciences at an earlier stage of development of the youngsters (such as for instance the French programme 'la main à la pate');
- The stimulation of more women to pursue a scientific career in science, also by creating favourable conditions, including part time work, temporary employment, opportunity for home working, provisions for children, etc. As was rightly observed by the Commissioner there is a large potential of so far suboptimally utilised female scientific research capacity in Europe.
- The stimulation of networks of excellence, but in a somewhat more flexible way than is envisaged in the 'new instruments' in FP6. Networks could be also smaller in scale, less stable, more temporary and more on an ad hoc basis. The idea is that scientists in Europe should enjoy being able to capitalise on all the available top-expertise, which might be spread throughout the continent. Such an increased flexibility and mobility should contribute to making Europe an attractive region to work in research.
- The stimulation of flexible retirement in order to stop the outflow of experienced scientists and the loss of human capital via early and mandatory retirement programs. It is widely known that a considerable percentage (est. 25%) of senior scientists would prefer to continue their career if they would not be kept from doing so because of legal reasons (mandatory retirement) and/or working conditions (full time vs part time, executive and/or supervising responsibilities vs consultant and/or coaching tasks with respect to junior scientists). It would be worthwhile to pursue this venue to prevent or at least to relieve the pains of what the Germans would call the 'Nachwuchs'-problem, caused by the massive retirement of the baby boom generation of scientists in the coming decade.
- An increased mobility from outside Europe, by removing many formal, legal and informal obstacles that frustrate an optimal inflow of non-European scientists at present. Many such suggestions were brought to the fore at a recent Estonian Ministry of Education conference (September 19-20, 2002) on the theme: 'Flexible Europe: mobility as a tool for enhancing research capacity.'
- Investment in research infrastructure, equipment, computer facilities and travel funds for scientists. Generally, it is more the conditions and facilities for research than salaries or honoraria that attract scientists.

- The creation of sufficient room for free, science driven, basic research. Many young scientists are attracted to a research climate where scientific creativity is treasured, and pure scientific motives and criteria are predominant in the evaluation of projects and competition between scientists. It is clear that this type of climate is to be found primarily in university or research institute settings, supported by public funding. This is another argument for further stimulating governmental R&D funding in Europe.

- Paying more attention than in the past 'ivory tower' period to questions of public and social responsibility of scientists. Part of the present public reservation or even negativism with respect to (products or putative effects of) science and technology (modified food, genetic engineering, cloning of animals or even human beings, environmental degradation, nuclear energy) find their ground in a wrong presupposition that the essential condition of freedom and autonomy of science would exclude social and moral responsibility for its products and consequences. Contemplative and serious attention of scientists to these societal and ethical questions, and proper communication with the general public could mitigate some of the existing negative attitudes towards natural sciences.

(4) ALLEA fully endorses the plea for improving the EU intellectual property right legal framework, the international harmonisation and enforcement of IPR systems, and the promotion of the use of good practices in publicly funded research. The delay of an adoption of measures to establish a unified IPR system in Europe is detrimental to optimal investment in R&D. At the same time ALLEA is concerned about a number of worrisome aspects that have been brought into the fore by the ALLEA Standing Committee on Intellectual Property Rights, under the chairmanship of Prof. Roger Elliott. These aspects include the unfortunate tendency to tighten the rules for copying materials for own study, teaching and research, the tendency to inhibit the scientific re-use of data from (overprotected) databases, the increasing pressure of researcher's employers (university, institute, funding organization) to retain potentially profitable inventions against their wish their research results to be widely available for debate and retesting, the pressure on scientists to carry out the type of research that may result in patents, the passing of 'discoveries' for 'inventions' (which leads to deplorable initiatives to patent DNA-sequences). We have to guard against creating intellectual

property rights in knowledge that may be to the detriment of the academic freedom of exchange and access.

(5) Although the primary affinity of ALLEA (and its member Academies) lies at the 'science' pole of the 'science – applied science – development – implementation' chain, it can declare its adhesion to the various proposals on research- and innovation-friendly regulations, on the improvement of interactions between academia and industry, and on the amelioration of macro-economic, financial and fiscal conditions, in order to stimulate the research capacity in the private sector and the effective use of public financing for business R&D. ALLEA takes, however, the liberty to express one concern with respect to all these ideas and proposals, and that is the question whether the cutting-edge, curiosity-driven, fundamental research, which remains a prerequisite for true science development and innovation, will be sufficiently safeguarded, if industry and the private sector in general are determining too much the research agenda. It should be acknowledged that the optimal balance between science and technological application may vary over European countries, depending on the level of economic development and growth, but at the same time it can be defended that a forced and excessive inclination to steer scientific research towards application and technological development is detrimental not only for science development itself, but in the long run also for the development of technological applications. New technologies require new knowledge, and that is generated by science-driven research.

European Convention

Under the chairmanship of Giscard d'Estaing a committee of representatives of the different EU-Member States (European Convention) has worked over the past year to draft a Treaty establishing a Constitution for Europe, in which the rules and regulations for future Europe are proposed. Already in November 2002 the European Research Advisory Board (EURAB) stipulated that research (basic research, applied research and technological development) plays a crucial role in the knowledge society and should be adequately defined and be acknowledged explicitly in the Treaty. Various other European research organizations have joined EURAB and have made similar suggestions.

ALLEA has also taken the liberty to address the European Convention on the issue of the importance of scientific and scholarly research, and its indispensability for both the intellectual and cultural development, and societal and economic welfare. In a letter to the Convention it has taken the following position and made the following suggestions:

A more defined and acknowledged space should be devoted to scientific and scholarly research (both fundamental science-driven research and applied research that tries to meet the needs of society) in the Constitutional Treaty. The national academies of sciences and humanities in Europe are convinced that 'science matters'. Not only do they believe in the intrinsic value of scientific knowledge in a civilized society, they are also confident that proper scientific research is indispensable for the desired development of societies and the well-being of mankind. And this desired development includes economic development. Experts agree that the stimulation of research and development is a crucial part of the solution of Europe's declining competitiveness and, its consequence, the rising levels of unemployment.

A 'green' paper, published by the European Commission some time ago, spoke about the 'European paradox', suggesting that in comparison with its principal competitors in the world the production of high level knowledge of the EU states was still first-rate, but that Europe seemed insufficiently able to transform this knowledge into useful technological applications. This would be a strong argument for an increased effort in the area of applied research and technological development.

But there is more at the present moment. If one notices the relatively large number of American (based) Nobel prizes, the much higher investment of European companies in the USA than vice versa, the large number of high level European scientists who are attracted (and hired) by top American universities and the distressingly limited brain drain from the USA to Europe, and the fact that the EU engages substantially fewer researchers than the US and Japan (as was brought to light by the Third European Report on Science and Technology Indicators, 2003), there is ground for concern: European science seems on the wane. This concern is further intensified by the stagnation of R&D expenditure in Europe over the last five years, whereas it has been significantly growing both in the US and Japan. If Europe wants to (re)gain a prominent position in innovative industrial and technological developments it has to take the promotion of science and science education more seriously.

And for Europe there are attractive challenges in this respect. The international nature of science and scholarship has always been apparent, but it has become particularly conspicuous in present times through the widespread use of fast and powerful means of communication. And the opportunities for European science and scholarship are great, in particular if the European countries are able and willing to unite their efforts, and if they allow Europe to capitalize its rich expertise and knowledge. Some of these ideas were already specified in the proposals of the European Commissioner Busquin articulated in the European Research Area, and in the preliminary thoughts expressed by the European scientific community on a projected European Research Council. ALLEA has taken cognisance of a letter from the European Research Advisory Board (EURAB) on this issue and endorses wholeheartedly the thrust of this letter.

ALLEA concluded by saying that it would like to see in the Treaty a stronger promotion of the view that economic prosperity as well as the furthering of welfare, well-being, justice, and other societal values in the 21st century can only be achieved in the context of the development of a knowledge-based society, and therefore requires an appropriate acknowledgement and considerable support of scientific and scholarly research and education.

In the meantime the draft Treaty has become available, and in the formulation of the articles concerned the restriction of the definition of 'research' to short term, targeted research and the confinement of its expected value to economic utility and the contribution to technological development is far from illusory. ALLEA has, therefore, decided to make an additional plea, this time more specific in support of fundamental, science driven research in the following terms:

"In line with its earlier letter to the European Convention (dd. 07-05-'03) ALLEA , the European Federation of National Academies of Sciences and Humanities, would take the liberty of pleading again for a more acknowledged place for fundamental, investigator driven scientific and scholarly research".

In Section 9 (article III-146) of the draft Treaty that has been submitted to the Presidency of the European Council the Convention's viewpoint was phrased as follows: "The Union shall aim to strengthen the scientific and technological bases of Union industry and encourage it to become more competitive at international level, while promoting all the research activities deemed necessary by virtue of other chapters of the Constitution".

It is ALLEA's opinion that in this statement too little room is left for fundamental or strategic research and knowledge, and for maintaining and strengthening the great European intellectual and cultural tradition. Not only does it insufficiently acknowledge both the intrinsic value of scientific knowledge in a civilized society, and the need for basic research and knowledge for the furthering of a harmonious cultural, social and democratic development of a society, it also too little recognizes that basic science-driven research is a sine qua non for really innovative technological and economic developments. If the ambitious and laudable objectives of the strategy adopted by the Councils of Lisbon and Barcelona are to be realized, and if the European Union is to develop into one of the most competitive knowledge-based economies of the world, more importance should be attached to the social, cultural and economic significance of basic scientific knowledge and scholarship.

ALLEA would make so bold as to urge the European Council to accept an additional phrase in Art.III-146, section 1, on the promotion of scientific knowledge and to express its support for fundamental scientific and scholarly research without immediate reference to (short term) economic utility or technological application…."

Other European science organizations have taken more or less similar positions, and in order to enforce the possible impact a concerted action was undertaken at the recent World Science Forum in Budapest (8-10 November, 2003), by emitting an open letter to the Research Ministers in the EU Member states and countries that will join the EU on 1 May 2004, signed by the Presidents of All European Academies, the European Science Foundation, the European Academy of Sciences and Arts, Academia Europaea and Euroscience. The open letter is phrased as follows:

- *The European scientific community recognises the significance of the Constitution for Europe in shaping the future development of the Union. Impact of science and scholarship is a crucial tool that will underpin many aspects of this development.*

- The draft Constitution for Europe is a considerable step towards the establishment of a solid legal basis for scientific co-operation in an enlarged Europe. But in its present formulation the draft Constitution for Europe is not ensuring optimal possibilities for scientific co-operation and progress in Europe.
- In Section 9, Article III-146, too little room is left for fundamental or strategic research and knowledge, and for maintaining and strengthening the great European intellectual and cultural traditions. The European scientific community urges the Research Ministers to intervene with the European Council to accept an additional phrase in Article III-146, point 1, on the promotion of scientific knowledge without immediate reference to (short term) economic utility or technological application. The Union's support for fundamental scientific and scholarly research and scholarship in our collective future development needs to be explicitly stated.

- Further, the European scientific community wishes to stress that the Constitution for Europe should alleviate the threat of creating a Europe of two (or more) speeds in the research area. The scientific communities of Periphery Countries and Regions must be well integrated into the European mainstream of research.

Appropriate reference is necessary to be included in Article III-148.

European Research Council

An editorial comment in Nature (21 June, 2001) cautioned the ERA by saying that it is likely to remain a bloodless vision unless there is an independent, flexible and self-administered pan-European funding body which – unlike the ponderous Framework – can react quickly to unexpected scientific developments.

As an almost immediate compliance with this precondition the ideas on the creation of a European Research Council have gained momentum through the preparatory work of the European Research Council Expert Group (ERCEG), which was set up on the initiative of the Danish Minister of Science, Technology and Innovation during the Danish EU-Presidency. The ERCEG has made use of a variety of viewpoints, comments and reactions that have been evoked by the position paper on a possible ERC that the the Danish Research Councils distributed as background paper for an invited conference on this subject in Copenhagen, October 2002. ALLEA has also submitted a viewpoint which was taken after ample consulting with all its Member Academies. The main elements in this viewpoint were the following:

Given the widening gap between Europe and its main global rivals in the field of science and technology and the decrease or stagnation of the research funding in many European countries a concentrated effort to develop a true and partly remodelled European research policy, including its funding, is necessary. For this 'European Research' we need more that the sum of the different national research programmes, the intergovernmental cooperation agreements (Eureka, Cost), the cooperative arrangements within some disciplines, such as AMICA (agriculture) and CERC3 (chemistry), or the 'big science' institutes such as CERN, EMBO, ESA, ESO, as we have at present. ERA and FP6 are important steps forward, but remain Community instruments, for which consent of the partners is needed (art. 166 Treaty of Amsterdam). In the context of the FP's it will be extremely difficult to transfer (some of the) national resources to the European level. Moreover, the requirement of fair participation and acceptance of countries in collaborative projects for formal (political?) reasons may be laudable and defendable given the need to build a balanced research workforce all over Europe, and to help and train the less advantaged participants, but does not always lead to top performance and excellence.

The linking of national programmes into a truly European research policy so far has proven very difficult to achieve. Policies and funding remain predominantly national. The principle of 'juste retour' determines actions and attitudes.

ESF has made some significant steps forward, including EUROCORES (transnational cooperation between national research foundations; there is variable geometry, but each EUROCORE consists of at least four different participating European countries), Forward Look (as a solid basis for EUROCORES) and Research Networks. But so far it has not been possible to create a truly European Research Fund with substantial autonomous policy making and independent review and funding procedures. Likewise, EUROHORCS has taken a good initiative (29-04-02) with its 'European Young Investigator Awards', a funding scheme for selected young researchers (from anywhere in the world) to be supported for a stay of two to five years at a European institute or university. In all these initiatives, however, we are dealing with a very modest contribution. ALLEA, therefore, concludes that:

- Europe needs an integrated European science and research policy that sees Europe as an entirety that is more than the mere sum of individual nations.
- Europe needs a European representation of the intermediate level of policy- and decision-making and funding of scientific research.
- The implicit goal of the ERA (the creation of a European research funding mechanism by pooling of EC funding and national resources) should be endorsed.
- Europe needs a new and generally accepted mechanism for the enhancement and promotion of quality research, for the funding of joint programmes and for coordination of existing programmes.
- For the realization of these goals a European Research Council seems to be an important and effective vehicle.

In addition, ALLEA formulated a number of conditions for such an ERC, the most important of which were that:

- The ERC should be run by highly esteemed scientists and should operate independent of national governments and the European government,
- Quality and the promotion of excellence should be the primary guidelines, to be judged by peer reviewing.
- Research programmes should include the training of (excellent) young researchers.
- The task and responsibilities of the ERC must not replace or compete with existing systems of coordination and financing of research in Europe. Therefore, coordination with existing European programmes (Framework programmes, Eureka and others) should be pursued.
- Financing should be provided by pooled contributions of EU funds (FP and other funds), National Research Organizations (National Research Councils or Academies), and private funds. Highness of respective contributions is subject for further debate, but some matching EC and national funding is desirable.
- As far as introduction and development are concerned one should think of a gradual evolution rather than an attempt to start with a full-fledged Council at short notice.
- With respect to the participation of the Central and Eastern European states (the non-(candidate) EU members) financial and other conditions have to be worked out, but a liberal and generous participation policy

should be pursued. This not only for reasons of fairness and European solidarity, but also for reasons of salubrity and benefit for the European science: we need to mobilise all the scientific expertise available in the whole of Europe!

In an iterative process the ERCEG has made public various draft versions of its report, asking the various European science organizations to react on their proposals. The final report will be made available in December 2003. On the basis of the latest draft versions of the ERCEG report it can be inferred that the ERCEG will propose to set up a European Research Fund for fundamental research, which must be managed at arm's length from the political system. It will further propose that the European Union sets up a European Research Council (ERC) as a major new European entity, with full autonomy in its operation and granting decisions. Since the ERC, according to the proposal, must be created by the European Union (and thus by the heads of state) it should be politically accountable to the EU, but it must operate as a scientifically autonomous body, based on the advice and guidance of the European research community. The main task of the ERC is to fund investigator-driven fundamental research of the highest quality in a strongly competitive mode, with applications evaluated by international peer review. The budget for the European Research Fund is to be received from the EU after approval from the European Parliament, most likely as a special line in the budget for the EU Framework Programme.

By the end of this year (2003) the European Commission will make public its (new) position with regard to basic research, and in spring next year it will publish a Communication on the European Research Council. Let us hope that the Commissioner will propose and find support for the promotion of a stronger European base for research and knowledge as well as sufficient room for basic, investigator driven research, in which an ERC, as foreseen by the ERCEG and as presently supported by most of the European stakeholders in the field of research and scholarship, will be granted a central role.

Section II
Activities and Communications

Activities and Representations of President and Office

23/1	Meeting with Dutch Minister of Education, Science and Culture on ALLEA's possible contribution to a European meeting on 'Science and Society' during the Dutch presidency of EU (second half 2004), The Hague, The Netherlands
27/1	Second preparatory meeting for Amsterdam plus 7 (i.e. second preparatory) Conference on 'Scientists' responsibility', Bern, Switzerland.
28/1	Meeting DG XII on Action 19 of Action Plan 'Science and Society', Brussels, Belgium.
29-31/1	Visit Slovak Academy of Sciences (Prof. Stefan Luby, President). President Drenth receives Slovak Academy of Science Award for contribution to the promotion of science. Invited address on subject 'Growing Anti-intellectualism in Europe: A Menace to Science', Academy of Science, Bratislava, Slovak Republic.
19/2	Participation Executive Secretary in Preparatory meeting EuroCRIS Conference, Antwerp, Belgium
26/2	Meeting Advisory Group European Science Foundation, Frankfurt, Germany
17-19/3	Attending conference of the *Deutsche Akademien der Wissenschaften* on the advisory role of Academies of sciences and humanities, Heidelberg, Germany.
3-4/4	Attending meeting of the ESF council in Barcelona, Spain. Presentation of ALLEA Review Report of ESF Standing Committees on Social Sciences and Humanities.

5-9/4 Conference 'Ethics and the European Space', organized by the ALLEA Standing Committee on Science and Ethics in Les Treilles, France. Two presentations (President): 'Freedom and Responsibility', and 'Scientific Integrity and Good Practice'. Presentation (Director): 'Ageism in Science; Fair-play between Generations'.

30/4-4/5 Conference Industrial Democracy in Europe, in Social Science Research Centre, Dubrovnik, Croatia. Presentation paper on 'The Use of Science Results in Governance and Decision Making'

8/5 Meeting with Prof. Eyskens and Prof Schamp of the Flemish Academy of Belgium for Sciences and the Arts on the theme and programme of the ALLEA General Assembly in Brussels, March 2004, Brussels, Belgium.

15/5 Meeting with Chinese Deputy on Science and Technology, Mr. Wu Jian, Amsterdam, The Netherlands.

23/5 Presentation on 'Ethical constraints in science', BeNeLux University Centre, Eindhoven, The Netherlands.

26/5 Representation at the 195th Anniversary of the Royal Netherlands Academy of Arts and Sciences, Amsterdam, The Netherlands.

3/6 Presentation on 'Ethical dilemma's in sciences'. Probus, Amsterdam, The Netherlands.

5-6/6 Attending meeting European Academies' Science Advisory Council, Rome, Italy

19/6 Participation (as member supervisory team) in Ph.D-promotion of Dr. Heide Hackmann, secretary ALLEA's ESF-Review Committee. Twente University, Enschede, The Netherlands.

27/6 Circulation of second letter of ALLEA on its position regarding the European Research Council.

3/7 Reception American Embassy celebrating Independence Day, The Hague, The Netherlands.

10/8 Discussion with Dutch Minister of Science and Education on European research policy in regard of the Dutch Presidency, second half 2004. The Hague, The Netherlands.

18/9 Participation Director in Conference of EuroCris, Brussels, Belgium. Presentation: The Possible Contribution of ALLEA'.

26/9 Attending Regional Meeting of ICSU, Amsterdam, The Netherlands.

30/9 Reception Chinese Embassy, welcoming Chinese Ambassador in The Netherlands, Mme Hue Ilanqin, The Hague, The Netherlands.

7-9/10 Visit (President and Director) Montenegrin Academy of Sciences and Arts: Orientation and discussions of possible ALLEA-membership, Podgorica, Montenegro.

16-19/10 Meeting Board and General Assembly Leopoldina, Halle, Germany.

21-22/10 Attending ELSF-Euroscience Conference on 'European Research Council for all sciences', Presentation ALLEA's view on ERC, Dublin, Ireland.

25/10 Address 'Integrity in Science' to joint meeting of Royal Belgian Academy of Sciences and Belgian Academy of Medicine, Brussels, Belgium.

29/10 Participation in Royal Palace Meeting 'Gene technology, ethics and legislation', and diner, Amsterdam, The Netherlands. Host: Her Majesty Queen Beatrix.

30-31/10 Steering Committee meeting at the British Academy, London, United Kingdom.

5/11 Attending the presentation of the Praemium Erasmianum 2003, Royal Palace, Amsterdam, The Netherlands.

7-10/11 Attending Budapest Science Forum, Hungarian Academy of Sciences, Budapest Hungary. Invited address: ‘Science: Does it matter?’

10/11 Evening of Science and Society on 'Knowledge based economy'. Ridderzaal, The Hague, The Netherlands.

24-25/11 Attending Meeting European Academies Science Advisory Council, Dublin, Ireland.

26/11 Consultation with Dutch Minister of science, education and culture, The Hague, The Netherlands.

27-28/11 Attending Meeting European Science Foundation, Strasbourg, France.

1-5/12 Participation as observer Inter Academy Panel, Mexico City, Mexico. Presentations on ‘Nature and objectives ALLEA’, and 'Integrity in Science’.

14-15/12 Participation (President and Director) in meeting of ALLEA Standing Committee on Science and Ethics, Düsseldorf, Germany.

European Research Council
Summary of Proposed View ALLEA

Pieter J.D. Drenth

To ALLEA Member Academies,

[In the following a revised proposal can be found for a position taken by ALLEA in the debate on the possible creation of a European Research Council (ERC). Quite a few reactions on the first draft have been received from the Member Academies, which has lead to a number of amendments on the original position. In addition my partaking in the recent Conference in Copenhagen has led to some additional thoughts, which also have been incorporated in the revised stance. I do appreciate a continuation of the debate and would welcome further reactions]

Antecedents:

- In January 2000 the European Commission launched a proposal for the realization of a European Research Area, trying to bring more coherence into Europe's highly fragmented science and research landscape.
- At the Lisbon summit of March 23 and 24 2000 the Heads of State and Government of the European Union Member States endorsed the ERA ambitions for Europe to become the most dynamic and competitive knowledge-based economy in the world by the year 2010.
- The 6th Framework Programme for Scientific Research and Technological Development, which was designed as an instrument for realization of the ERA, will be launched on 1 Jan. 2003 with a budget of 17.5 Billion Euro.
- On Oct. 7-8 2002 the Danish Research Councils have organized (during the Danish Presidency of the European Union) a conference on the theme ´Towards a European Research Area: Do we need a European Research Council?´ As your President I have represented ALLEA at this conference.

- The European Science Foundation (ESF) has asked a high level working group to prepare a position paper for ESF on this issue, which will be discussed at the General Assembly meeting in Strasbourg Nov. 28-29 this year. Beginning 2003 a definite standpoint will be formulated.

Considerations:

- Given the widening gap between Europe and its main global rivals in the field of science and technology and the decrease or stagnation of the research funding in many European countries, a concentrated effort to develop a true and partly remodelled European research policy, including its funding, is necessary.
- For this ´European Research´ we need more than the sum of the different national research programmes, the intergovernmental cooperation agreements (Eureka, COST), the cooperative arrangements within some disciplines, such as AMICA (agriculture) and CERC3 (chemistry), and the "big science" institutes such as CERN, EMBO, ESA, ESO, as we have at present.
- ERA and FP6 are important steps forward, but remain Community instruments, for which consent of the partners is needed (art.166 Treaty of Amsterdam). In the context of the FP's it will be extremely difficult to transfer (some of the) national resources to the European level. Moreover, the requirement of fair participation and acceptance of countries in collaborative projects for formal (political?) reasons may be laudable and defendable given the need to build a balanced research workforce all over Europe, and to help and train the less advantaged participants, but does not necessarily lead to top performance and excellence.
- The linking of national programmes into a truly European research policy so far has proven very difficult to achieve. Policies and funding remain predominantly national. The principle of ´juste retour´ (do I get more or at least as much out of it as I put into it?) determines actions and attitudes.
- ESF has made some significant steps forward, including EUROCORES (transnational cooperation between national research foundations; there is variable geometry, but each EUROCORE consists of at least four different participating

European countries), Forward Look (as a solid basis for EUROCORES) and Research Networks, but so far it has not been able to create a truly European Research Fund with substantial own and independent (from national funding organizations) policy making and review and funding procedures.
- EUROHORCS has taken a good initiative (29-04-´02) with its ´European Young Investigator Awards´, a funding scheme for selected young researchers (in fact, from anywhere in the world) to be supported for two to five years at a European institute or university, but it is only a modest contribution.

Standpoint:
- Europe needs an integrated European science and research policy that sees Europe as an entirety that is more than the mere sum of individual nations.
- Europe needs a European representation of the intermediate level of policy- and decision-making and funding of scientific research.
- The implicit goal of the ERA (the creation of a European research funding mechanism by pooling of EC funding and national resources) should be endorsed.
- Europe needs a new and generally accepted European mechanism for the enhancement and promotion of quality research, for the funding of joint programmes and for coordination of existing programmes.
- For the realization of these goals a European Research Council seems to be an important and effective vehicle.

Conditions:
- ERC should be run by scientists and scholars and operate independent from national governments and the European government. At the same time a system of periodic critical assessment and evaluation of the goals and achievements should be developed.
- The Council should consist of representatives of national funding organizations in all participating countries (preferably

not more than two per country). National funding systems will remain to be important constituents; cooperation with them will be essential.

- The Council should be highly regarded by the scientific community. This can best be achieved by appointing scientists and scholars with very high credentials in the scientific community as members.
- Quality and the promotion of excellence should be the primary guidelines, to be judged by peer review. Research programmes should include the training of (excellent) young researchers.
- The task and responsibilities of the ERC must not replace or compete with existing systems of coordination and financing of research in Europe. Therefore, coordination with existing European programmes (Framework programmes, Eureka and others) should be promoted.
- Less emphasis should be put on the distinction ´basic – applied research´; the distinction is getting outdated, some basic research proves extremely useful, and applied research can contribute significantly to the augmentation of knowledge; essential is methodologically correct and solid research.
- It is legitimate to give (some) priority to strategic research relevant for Europe. Prioritising should be performed by scientists and politicians (European Commission, Council of Ministers, European parliament) jointly.
- Financing should be provided by pooled contributions of EU funds (FP and other funds), National Research Organizations (National Research Councils or Academies), and private funds. Highness of respective contributions is subject for further debate, but some matching EC and national funding seems desirable.
- As far as introduction and development are concerned one should think of a gradual evolution rather than an attempt to start with a full-fledged Council at short notice. Many national and international negotiations and consultations are needed, and a too rapid build-up may backfire. ´Gradual´ may refer to percentages of the national budgets for research to be submitted (for instance up to between 5 and 10% by 2010), fields of sciences and humanities to be involved, or definition of tasks

and responsibilities. The gradual development could lead to a full realization by the beginning of FP7.

Some final observations:

- The FP programmes should be continued. They have a unique and very important function in the furthering of collaboration and mobility of researchers from different countries in Europe.
- With respect to the participation of the Central and Eastern European states (non-(candidate) members financial and further conditions have to be worked out, but a liberal and generous participation policy should be defended. This not only for reasons of fairness and solidarity, but also for reasons of salubrity and benefit for European science: we need to mobilize all the scientific expertise available in the whole of Europe.
- The question whether the ERC should (eventually) replace or complement the ESF is a matter of further developments and deliberations within the ESF. Some of the goals and activities of the ESF are certainly in line with the envisaged ERC, and could suggest an eventual replacement or at least patronage of the ESF. Others may have a more unique ESF-character. It certainly would not be wise to dissolve ESF in favour of ERC at short notice.
- National Academies (either as learned societies or as funding agencies, or both) will continue to play a significant role in the development and promotion of national science and scholarship. The same counts at the European level for the association of national Academies (ALLEA). For some of its concerns and tasks a future ERC might invoke the assistance of ALLEA; one could think of the system and (wo)manning of peer reviewing, advice on ethical problems in science, on free versus sponsored research, on intellectual property rights, and others. ALLEA is willing to assent to such an eventual invocation.

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Letter to EU Commissioner Busquin on the 3% Initiative

Dear Commissioner Dr. Busquin,

Thank you for sending us the Communication from the Commission on ´More research for Europe´, and for inviting ALLEA to give its views on these proposals. ALLEA is happy to share with you its views on the ideas and suggestions as presented by your communication. We would like to offer the following points for further consideration.

1. ALLEA agrees with the view that the creation of a European Area of Research and Innovation is a key condition for the European Union to become a leading knowledge based economy in the world, and that the objective to raise the percentage of European GDP to be spent on R&D from the present 1.9% to 3% by the year 2010 is both ambitious and laudable. Although ALLEA shares with you the concern about an increasing concentration of R&D expenditures of multinational companies in the US, and about decreasing R&D investments of European national companies and SME's in particular, and although we agree also with your plea for a reversal of this tendency and for an increase of the private sector's share of the R&D efforts, ALLEA finds the suggestion that the primary contribution to the expected increase to 3% has to come from the industrial and private sector somewhat easy and without engagement. Since quite a number of EU-nations can already claim that the percentage of their public spending on R&D is reaching or approaching the level of 1%, the objective in question will hardly be an incentive for further exertions for their governments. And this is regrettable in our view.

2. It is quite accurate to point to the existing diversity of national and regional situations both in terms of overall level of R&D investments and the balance government-business funding and to plea for differentiated policies towards the 3% objective. It is in particular the candidate countries in which the share of the business funding remains very low. ALLEA would have

appreciated a somewhat more specific elaboration of this differentiated policy, and the specific support which the Commission has in mind. In this connection we take the liberty to refer to a recent report of a ALLEA-working group under the chairmanship of Prof. Jüri Engelbrecht, President of the Estonian Academy of Sciences (´National Strategies of Research in Smaller European Countries´, Amsterdam, ALLEA Report Series, no. 1), in which a number of recommendations and steps to be taken by policy-makers are suggested, in order to develop a strategy of research in smaller European countries. The recommendations include ensuring the quality of research, capitalising on the existing strengths, achieving an optimal balance between science-driven research and meeting society's needs, stimulation of networking, mobility and (small scale) cooperation, strengthening of the administration and improvement of the research infrastructures.

3. ALLEA shares your grave concern about the declining attractiveness of natural sciences and engineering among students and young researchers in many European nations, a tendency, which is even, aggravated by a growing net outflow of S&T human resources from Europe to the US. Great pains should be taken to stem this unfortunate development. Various measures and strategies could be considered, including:
    - The encouragement to develop and to implement programmes for raising interest in sciences at an earlier stage of development of the youngsters (such as for instance the French programme ´la main à la pate´);
    - The stimulation of more women to pursue a scientific career in science, also by creating favourable conditions, including part time work, temporary employment, opportunity for home working, provisions for children, etc. As you observe, there is a large potential of so far suboptimally utilised female scientific research capacity in Europe.
    - The stimulation of networks of excellence, but in a somewhat more flexible way than is envisaged in the ´new instruments´ in FP6. Networks could be also smaller in scale, less stable, more temporary and more

on an ad hoc basis. The idea is that scientists in Europe should enjoy being able to capitalize on all the available top-expertise, which might be spread throughout the continent. Such an increased flexibility and mobility should contribute to making Europe an attractive region to work in research.

- The stimulation of flexible retirement in order to stop the outflow of experienced scientists and the loss of human capital via early and mandatory retirement programs. It is widely known that a considerable percentage (est. 25%) of senior scientists would prefer to continue their career if they would not be kept from doing so because of legal reasons (mandatory retirement) and/or working conditions (full time vs part time, executive and/or supervising responsibilities vs consultant and/or coaching tasks with respect to junior scientists). It would be worthwhile to pursue this venue to prevent or at least to relieve the pains of what the Germans would call the ´Nachwuchs´ problem, caused by the massive retirement of the baby boom generation of scientists in the coming decade.
- An increased mobility from outside Europe, by removing many formal, legal and informal obstacles that frustrate an optimal inflow of non-European scientists at present. Many such suggestions were brought to the fore at a recent Estonian Ministry of Education conference (Sept 19-20,'02) on the theme: 'Flexible Europe: mobility as a tool for enhancing research capacity.'
- Investment in research infrastructure, equipment, computer facilities and travel funds for scientists. Generally, it is more the conditions and facilities for research than salaries or honoraria that attract scientists.
- The creation of sufficient room for free, science driven, basic research. Many young scientists are attracted to a research climate where scientific creativity is treasured, and pure scientific motives and criteria are predominant in the evaluation of projects and competition between scientists. It is clear that this type of climate is to be found primarily in university or research institute

settings, supported by public funding. This is another argument for further stimulating governmental R&D funding in Europe.

- Paying more attention than in the past 'ivory tower' period to questions of public and social responsibility of scientists. Part of the present public reservation or even negativism with respect to (products or putative effects of) science and technology (modified food, genetic engineering, cloning of animals or even human beings, environmental degradation, nuclear energy) find their ground in a wrong presupposition that the essential condition of freedom and autonomy of science would exclude social and moral responsibility for its products and consequences. Contemplative and serious attention of scientists to these societal and ethical questions, and proper communication with the general public could mitigate some of the existing negative attitudes towards natural sciences.

4. ALLEA fully endorses your plea for improving the EU intellectual property right legal framework, the international harmonisation and enforcement of IPR systems, and the promotion of the use of good practices in publicly funded research. The delay of an adoption of measures to establish a unified IPR system in Europe is detrimental to optimal investment in R&D.
   At the same time we would like to stress a number of concerns that have been brought into the fore by the ALLEA Standing Committee on Intellectual Property Rights, under the chairmanship of Prof. Roger Elliott, which include the unfortunate tendency to tighten the rules for copying materials for own study, teaching and research; the tendency to inhibit the scientific re-use of data from (overprotected) databases; the increasing pressure of researcher's employers (university, institute, funding organization) to retain potentially profitable inventions against their wish their research results to be widely available for debate and retesting; the pressure on scientists to carry out the type of research that may result in patents; the passing of 'discoveries' for 'inventions' (which leads to

deplorable initiatives to patent DNA-sequences). We have to guard against creating intellectual property rights in knowledge that may be to the detriment of the academic freedom of exchange and access.

5. Although the primary affinity of ALLEA (and its member Academies) lies at the 'science' pole of the 'science – applied science – development – implementation' chain, it can declare its adhesion to the various proposals on research- and innovation-friendly regulations, on the improvement of interactions between academia and industry, and on the amelioration of macro-economic, financial and fiscal conditions, in order to stimulate the research capacity in the private sector and the effective use of public financing for business R&D.
   ALLEA would however take the liberty to express one concern with respect to all these ideas and proposals, and that is the question whether the cutting-edge, curiosity-driven, fundamental research, which remains a prerequisite for true science development and innovation, will be sufficiently safeguarded, if industry and the private sector in general are determining too much the research agenda. We acknowledge that the optimal balance between science and technological application may vary over European countries, depending on the level of economic development and growth, but in any case it can be defended that a forced and excessive inclination to steer scientific research towards application and technological development is detrimental not only for science development itself, but in the long run also for the development of technological applications. New technologies require new knowledge, and that is generated by science-driven research.

Dear Commissioner Busquin, we hope to have served you with these comments. Please feel free to ask for further clarification if need be. In the meantime I remain yours sincerely,

Pieter J.D. Drenth,
President ALLEA

Letter to the European Convention

European Convention
Wetstraat 175
B-1048 BRUSSELS
BELGIUM

Amsterdam, 6 May 2003

Dear Sir, Madam,

ALLEA (All European Academies) is the European network of National Academies of Sciences and Humanities. It was created when new opportunities for cooperation arose in the 90s as a result of the end of the cold war, and in the context of the increasing significance of supra-national organizations and institutions in the area of science and higher education. At present it has 48 members (i.e. national academies) from virtually all European countries from the Atlantic to the Urals.

ALLEA would like to take the liberty of pleading for a more defined and acknowledged place for scientific and scholarly research (both fundamental science-driven research and applied research that tries to meet the needs of society) in the Constitutional Treaty that your esteemed Council is developing. The European Academies of Sciences and Humanities, united in ALLEA, are convinced that 'science matters'. Not only do they believe in the intrinsic value of scientific knowledge in a civilized society, they are also convinced that proper scientific research is indispensable for the desired development of societies and the well-being of mankind. And this desired development includes economic development. Experts agree that the stimulation of research and development is a crucial part of the solution of Europe’s declining competitiveness and, its consequence, the rising levels of unemployment.

A 'green' paper, published by the European Commission some time ago, spoke about the 'European paradox', suggesting that in comparison with its principal competitors in the world the production of high level knowledge of the EU states was still first-rate, but that Europe seemed insufficiently able to transform this knowledge into useful technological applications. This would be a strong argument for an increased effort in the area of applied research and technological development. But there is more at the present moment. If one notices the relatively large number of American (based) Nobel prizes, the much higher investment of European companies in the USA than vice versa, the large number of high level European scientists who are attracted (and hired) by top American universities and the distressingly limited brain drain from the USA to Europe, and the fact that the EU engages substantially fewer researchers than the US and Japan (as was brought to light by the Third European Report on Science and Technology Indicators, 2003), there is ground for concern: European science seems on the wane. This concern is further intensified by the stagnation of R&D expenditure in Europe over the last five years, whereas it has been significantly growing both in the US and Japan. If Europe wants to (re)gain a prominent position in innovative industrial and technological developments it has to take the promotion of science, including basic science, and science education more seriously.

For Europe there are attractive challenges in this respect. The international nature of science and scholarship has always been apparent, but it has become particularly conspicuous in present times through the widespread use of fast and powerful means of communication. And the opportunities for European science and scholarship are great, in particular if the European countries are able and willing to unite their efforts, and if they allow Europe to capitalize its rich expertise and knowledge. Some of these ideas have already been specified in the proposals of the European Commissioner Busquin articulated in the European Research Area, and in the preliminary thoughts expressed by the European scientific community on a projected European Research Council. ALLEA has taken cognisance of a letter from the European Research Advisory Board (EURAB) on this issue, and would like to endorse wholeheartedly the thrust of this letter.

In conclusion, ALLEA would like to see in the Treaty a stronger endorsement of the view that economic prosperity as well as the promotion of welfare, well-being, justice, and other societal values in the 21st century can only be achieved in the context of the development of a knowledge-based society, and therefore requires an appropriate acknowledgement and considerable support of scientific and scholarly research and education.

With respect and yours truthfully,

Pieter J.D. Drenth,
President ALLEA.

Standpoint of All European Academies (ALLEA) regarding the 'Constitution for Europe'

In line with its earlier letter to the European Convention (dd. 07-05-'03) ALLEA, the European Federation of National Academies of Sciences and Humanities, would take the liberty of pleading again for a more acknowledged place for fundamental, investigator driven scientific and scholarly research.

In Section 9 (article III-146) of the treaty that has been submitted to the Presidency of the European Council the Convention's viewpoint was phrased as follows: "The Union shall aim to strengthen the scientific and technological bases of Union industry and encourage it to become more competitive at international level, while promoting all the research activities deemed necessary by virtue of other chapters of the Constitution".

It is ALLEA's opinion that in this statement too little room is left for fundamental or strategic research and knowledge, and for maintaining and strengthening the great European intellectual and cultural tradition. Not only does it insufficiently acknowledge both the intrinsic value of scientific knowledge in a civilized society, and the need for basic research and knowledge for the furthering of a harmonious cultural, social and democratic development of a society, it also too little recognizes that basic science-driven research is a sine qua non for really innovative technological and economic developments. If the ambitious and laudable objectives of the strategy adopted by the Councils of Lisbon and Barcelona are to be realized, and if the European Union is to develop into one of the most competitive knowledge-based economies of the world, more importance should be attached to the social, cultural and economic significance of basic scientific knowledge and scholarship.

ALLEA would make so bold as to urge the European Council to accept an additional phrase in Art.III-146, section 1 on the promotion of scientific knowledge and to express its support for fundamental scientific and scholarly research without immediate reference to (short term) economic utility or technological application.

Pieter J.D. Drenth,
President ALLEA

Open letter to the Research Ministers in the EU Member States and Countries that will join the EU on 1 May 2004*

Make the "Constitution for Europe" more useful to the scientific community in an enlarged Europe

With this open letter, the European scientific community through the *European Federation of National Academies of Sciences and Humanities*, the *European Science Foundation*, the *European Academy of Sciences and Arts*, the *Academia Europaea*, and the *Euroscience* wishes to address the Research Ministers in the EU Member States and the countries that will join the EU on 1 May 2004:

1. The European scientific community recognises the significance of the Constitution for Europe in shaping the future development of the Union.

Impact of science and scholarship is a crucial tool that will underpin many aspects of this development.

2. The draft Constitution for Europe is a considerable step towards the establishment of a solid legal basis for scientific co-operation in an enlarged Europe.

But in its present formulation the draft Constitution for Europe is not ensuring optimal possibilities for scientific co-operation and progress in Europe.

3. In Section 9, Article III-146, too little room is left for fundamental or strategic research and knowledge, and for maintaining and strengthening the great European intellectual and cultural traditions.

The European scientific community urges the Research Ministers to intervene with the European Council to accept an additional phrase in **Article III-146, point 1,** on the promotion of scientific knowledge without immediate reference to (short term) economic utility or technological application. The Union's support for fundamental

* Issued at the first **World Science Forum – Budapest**, 10 November 2003.

scientific and scholarly research and scholarship in our collective future development needs to be explicitly stated.

4. Further, the European scientific community wishes to stress that the Constitution for Europe should alleviate the threat of creating a Europe of two (or more) speeds in the research area. The scientific communities of Periphery Countries and Regions must be well integrated into the European mainstream of research.

Appropriate reference is necessary to be included in **Article III-148**.

Amsterdam / Strasbourg / Salzburg / London / Strasbourg,

November 2003.

On behalf of
ALLEA - European Federation of National Academies of Sciences and Humanities,
Prof. Dr. Pieter J.D. Drenth, President

European Science Foundation,
Prof. Dr. Enric Banda, Secretary General

European Academy of Sciences and Arts,
Prof. Dr. Dr. hc Felix Unger, President

Academia Europaea,
Prof. Dr. Jürgen Mittelstrass, President

Euroscience
Prof. Dr. Jean-Patrick Connerade, President

Excellence and Equal Access
to the European Research Area

Position paper of ALL European Academies (ALLEA) with regard to the further development of the European Research Area after the incorporation of the Accession Countries into the European Union

This memorandum forwards some ideas on the potential tension between the principle of competition for excellence and the objective of equal development with respect to the further development of the European Research Area and the funding of European research.

The incorporation of the Accession Countries (AC) into the European Union by May 1st 2004 will have a profound impact on the further development of the European Research Area (ERA). First of all it will result in a significant increase of human research potential (to be assessed at 200.000). This increase concerns in particular younger researchers, given the substantial growth of students applying to universities in these countries in recent years. On the other hand, the general level of R&D infrastructure in the AC's is significantly lower than in the present EU countries, due to lack of resources and other urgent social and economic needs in a period of transformation. Especially the R&D expenditure in the industrial and private sector, and, consequently, the level of applied, industry related research is relatively low. A fortunate circumstance is that networks of high-level research institutions (mostly at the top universities and research institutes of those Academies that decided to retain its research part) in AC's already exist, presenting a significant potential for multilateral collaboration and world class research. Some of them have already received the status of centres of excellence from the EU and in the long run will become natural linkage points.

One particular subject in which the potential tension between the principle of competition for excellence and that of equal development may become explicit is that of the envisaged European Research Council. According to the European Research Council Expert Group (ERCEG) the establishment of a European Fund for Research Excellence and the further creation of a European Research Council (ERC) to manage the Fund is a crucially important step to be taken in order to achieve the goals set by the Lisbon Summit for Europe to become the most competitive and dynamic knowledge-based economy in the world. The first and main task of this ERC is to support investigator-driven research of the highest quality in Europe selected through a competitive process of international peer review.

In the preliminary reactions of the European Commissioner Busquin and the Director of DG Research Mitsos to the work of the ERCEG and in their further views on the European funding of fundamental research, emphasis is repeatedly been placed on the idea of fostering basic research solely on the basis of competition without a requirement of collaboration or the fair distribution of funds between member states. As the sole criterion for the acceptance and funding of research proposals, open competition, international peer review, and scientific quality undeniably comprise a *sine qua non* for the promotion of top-level research in Europe.

At the same time it should be acknowledged that an exclusive emphasis on top quality and competition for excellence may not contribute to the realization of another important objective for Europe's scientific development. That objective is to assure that the growth of science and technology in the accession states (and eventually in the other Eastern European countries) is accelerated, so that in due course these countries have equitable opportunities for scientific development that are comparable to those in the Western European states. The final report of the ERCEG (The European Research Council; a Cornerstone in the European Research Area, Copenhagen, Dec. 15, 2003) also recognizes this danger in its discussion of the tension (at least in the short term) between the primary objective of the ERC, pursuing excellence in basic research, and one of the additional tasks, making better use of and developing the scientific potential of weaker regions, geographically or thematically. Due to less favourable economic conditions and sub-optimal infrastructures, many excellent scientists in Central and Eastern countries cannot compete on an equal footing with their Western colleagues.

Such a situation is objectionable not only for reasons of fairness and solidarity, but also for reasons of benefit and self-interest of European science: we need to mobilize all the scientific expertise available (cf.

ALLEA's reaction on the ERC-proposal). This concern is even more pertinent in the pre-accession countries as well as other European countries that envisage joining the EU further into the future. As said, many of the Central and Eastern European countries have an increasing number of well-trained, highly motivated students. Moreover, a great deal of these students have a strong interest in science and technical subjects - an interest which is declining at an alarming rate within the student population of Western Europe.

The same concern was raised in a recent open letter to Research Ministers in the EU member states, written on behalf of the major European academic and research organizations (All European Academies (ALLEA), the European Science Foundation (ESF), the European Academy of Science and Arts, Academia Europaea, and Euroscience), and stressing the need to make the "Constitution for Europe" more useful to the scientific community in an enlarged Europe. The letter articulates the desire of the European scientific community to alleviate the threat of creating a situation in which parts of Europe cannot participate in the envisaged acceleration of the research efforts. The scientific communities of the periphery countries and regions must be well integrated into the European mainstream of research.

The European Parliament has expressed similar concerns. This has become apparent in a recent report "On investing in research: an action plan for Europe" (com (2003) 226 2003/2148 (INI)) of the Committee on Industry, External Trade, Research and Energy. The report argues that in view of the EU's growing global responsibility, international research cooperation should be intensified. In this connection great importance is attached, among other things, to increased cooperation between Member states and Accession countries. In an explanatory statement the report defends the claim that....even if the applicant countries were to raise their expenditure, they would still be dependent on additional help from the EU.....

The issue being addressed in this memorandum was discussed by a number of representatives from Research Councils and Academies of Science at the recent general assembly meeting of the ESF, Nov. 27-28

2003, in Strasbourg. There the following views and suggestions were brought to the fore:

With respect to the envisaged funding of fundamental research within the scope of the ERC no compromise or concession should be allowed as far as the requirement of scientific excellence is concerned. Grants and subsidies should be given only to the best proposals and the best researchers or research groups in an open competition and based on reviews by international panels.

The same uncompromised criterion of quality should be applied to the granting of scholarships for the promotion of talent (Curie type programmes).

The disadvantaged position of scientists from a number of accession and pre-accession states with a less favourable economic status is, however, cause for concern. The general view was that *specific measures* should be taken to ensure that these countries are able to gain on Western European countries. It was also argued that such measures should be temporary ones, since there is no reason to assume that these countries will not draw level with the rest of Europe in due time. In line with these views, the following recommendations were made:

In order to make the environment for research more equal throughout Europe a part (say 10%) of the *structural funds* (in particular the European Regional Development Fund) should be reserved for research infrastructure in the accession countries. At present such funds are largely used by the receiving countries for purposes of building physical infrastructures, such as railways, roads, etc. Earmarking for the benefit of research facilities could also improve “roads for Europe” - but this time roads for brains rather than for cars. Means should be explored to intend (as a strategic demand or by agreement) an appropriate share of the structural funds for research, higher education and innovative infrastructures. It will also be clear that the matching condition for these funds would mean a disproportional encroachment on the already very modest AC R&D budgets, and that exemption of this requirement should be considered.

A share of the *coordination funds* (coordination of national research priorities) should be reserved for collaborative agreements with (pre-) accession countries.

Part of the *social funds* should be used to make up arrears with respect to the quality of secondary school education in science in accession countries. This could be accomplished by means of a programme for upgrading of science teachers, and particularly for those based in rural areas.

In order to counteract the danger of brain drain, which, on a large scale, is detrimental for many (pre-)accession countries, some of the scholarships for young researchers should be awarded *within* the country of residence. Such scholarships should include support for infrastructure, so as to make the research environment "at home" more attractive. Alternatively, scholarships that enable researchers to spend a number of years in a laboratory in another country, should provide support for their return (including employment for a specific period of time, as well as support for infrastructure and facilities). Some remedy instruments created within the FP6, including the centres of excellence programme, return grants, and bilateral research grants (with at least one partner from the current 15 EC members and one from the 10 AC's) should be continued. What really would help both for retaining and attracting excellent researchers in the AC's is the availability of some large experimental facilities built with EC funds in the CEE region, comparable to for instance the laser centre that was built in Crete some years ago.

With an eye on specific needs and potential contributions of accession countries, participation of experts from these countries in European planning-, advisory-, and review-committees should be warranted and encouraged. They are the persons par excellence who can bring in the necessary information and insight with respect to these countries. In this connection it may be noteworthy that EUROHORCS have started an initiative to map out the status of review systems in various accession countries, and to offer assistance when desired.

An over-emphasis on young researchers (Curie fellowships and others) in accession countries could have negative consequences for the necessary support of the older middle-range researchers - who are often lagging behind, but who are still responsible for managing and monitoring the research of younger staff members. In terms of the age of grantees leniency could be prudent.

The goal of preparing and upgrading pre-accession states may be best served by using Central European states as intermediaries. Scholarships and grants, as well as support for collaboration between those countries and the stronger and larger states like Poland, Hungary and the Czech Republic could create a good intermediary stage on the road towards equality within the greater Europe.

Let high profile research institutions in accession countries, including the national Academies of Sciences that have successfully made the transition to a new definition of tasks and different financial ruling, be involved in internal European Union grant procedures (for both students and researchers) as well as in the monitoring of the process. They know best how these programmes and grants could best fit the needs of the country.

We express the hope that (some of) the measures suggested above will prove feasible, and that their acceptance and implementation will contribute to the alleviation of the fear of a European science divide after May the 1st and in later years.

Amsterdam, January, 2004,
Prof. Dr. Pieter J.D.Drenth,
President ALLEA.

Section III

ALLEA – All European Academies

- Member Academies
- Steering Committee
- Standing Committees
- Working Groups

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