COMETS
CNRS Ethics Committee

OPINION n°2009-19

« THE ROLE OF THE SCIENTIFIC COMMUNITY IN THE DEBATE ON CHEMICALS »

Approved at the plenary session of 21 september 2009

WORKING GROUP MEMBERS:

Jacques Bordé
Jean-Pierre Bourguignon
Michel Campillo
Hubert Doubre
Andrée Marquet
Christine Noiville

RAPPORTEUR:

Andrée Marquet

I. SUMMARY

On the occasion of the implementation of the REACH Regulation,
at the initiative of the CNRS Director General.

Voted on 18 December 2006 by the European Parliament, the European REACH Regulation (Registration, Evaluation, Authorisation and Restriction of Chemicals) came into force on 1 June 2007. At the request of the French Ministry of Ecology, Energy, Sustainable and Regional Development (MEEDDAT) and the Ministry of Industry, the CNRS and the French National Institute for Research in the Environment and Health (INERIS) have set up a joint working group entitled "Chemicals: what are the scientific challenges in the REACH context?" with a view to producing a collective expert appraisal. At the same time, the CNRS Director General requested that this expert appraisal be accompanied by an analysis of the ethical issues posed by application of the regulation.

REACH is intended to be a major step forward in controlling the health and environmental impacts of both old and new chemicals placed on the market. It requires the risk knowledge gap to be bridged and full transparency to be ensured by manufacturers and importers towards public authorities, users and consumers. However, the implementation of these principles raises many questions (effective organisation of transparency, exact criteria for considering the substitution of substances of very high concern (SVHC) by alternatives, etc.). Moreover, as the REACH Regulation is planned to be updated in the light of new knowledge, many choices will have to be made in the years to come (will nanoparticles or substances produced in quantities of less than 1 tonne per year be covered by the regulation which, for the moment, does not apply to them?)

Far from being strictly technical, most of these choices have an ethical dimension. The first question to consider is what the ethical conditions for applying the regulation should be. How should research be conceived in a field that is now resolutely subject to the requirements of sustainable development and the precautionary principle? How can an expert appraisal be organised so as to meet the imperative of social trust that underlies the chemical sector in particular? To what should the obligation of transparency refer in a sector traditionally characterised by industrial secrecy?

More generally, it is worth emphasising the ethical implications of scientists' contribution to the debate on the implementation and development of the REACH Regulation. Whether their participation concerns the assessment and cost/benefit analysis of chemicals or the setting by public authorities of a level of chemical risk deemed acceptable, their contribution to this societal debate appears essential, especially since they have been little involved until now.

COMETS thus wishes to contribute to a debate at the crossroads of major societal issues without interfering in the work of the CNRS/INERIS working group but evolving in step with it.

CONTENTS

II. ANALYSIS

Voted on 18 December 2006 by the European Parliament, the European REACH Regulation (Registration, Evaluation, Authorisation and Restriction of Chemicals) came into force on 1 June 2007. It was designed to monitor the health and environmental impacts of chemicals. While the global production of chemicals increased from 1 million to 400 million tonnes between 1930 and 2007 and more than 100,000 different substances are currently on the market, the ecological and health effects of most of them are almost completely unknown. Despite regulations dating back to 1981 that require the assessment of chemicals placed on the market from that date onwards, many new products have been marketed without their toxicity for humans or the environment having been seriously studied[1]. Based on this observation, the REACH Regulation requires this lack of knowledge on the risks of chemicals currently in circulation to be remedied and the most toxic products to be withdrawn. It thus constitutes what everyone agrees is a major step forward from the previous situation.

At the request of the French Ministry of Ecology, Energy, Sustainable and Regional Development (MEEDDAT) and the French Ministry of Finance (Minefi), and with the support of the French research funding agency (ANR), the CNRS and INERIS have joined forces to conduct a collective expert appraisal on “Chemicals: what are the scientific challenges in the REACH context?" in order to define which avenues of research should be pursued to ensure that the regulation is enforced. At the same time, COMETS—whose remit is to promote ethical values in the world of research—intends to highlight in this Opinion those brought into play by the contribution of public research to the regulation’s implementation.

During the drafting of the regulation, the chemical industry and environmental associations were the main contacts for the European Commission and governments, while public research was almost totally absent from the discussions. Given the nature of the issues involved and the planned revision of the regulation, it is important for public research to participate in the debate while remaining fully aware of the ethical issues it may face.

What criteria should be used to assess chemicals and to determine, substance by substance, the level of risk deemed acceptable by our society? How can we ensure that the REACH Regulation leads to a truly virtuous process of chemical risk control? How can the expert appraisal be organised so that it meets the particularly stringent requirements of safety and social trust in this field? How should research be conceived in a sector that is now resolutely subject to the requirements of the precautionary principle and sustainable development?

Such questions have a strong ethical and social dimension that goes beyond their technical aspect. Indeed, they are of particular importance to public research because of all the elementary sciences, chemistry has the most extensive interaction with a strong and well-identified industry. This sector has a long history, during which the relationship between chemistry and the society in which it has developed has changed

[1] See the Commission's White Paper of 27 February 2001 on the Strategy for a Future Chemicals Policy, COM (2001) 88 final. Most of the almost 100,000 "existing substances", marketed before 1981, have never been assessed; about 3,800 "new substances" placed on the market since 1981 have theoretically been assessed by the public authorities, but in practice little is known about their effects. Only 193 of these were considered "at risk" and only 15 were fully assessed.

considerably. After a period of glory during which its indisputable contribution to technological progress was the dominant image, it has become an object of distrust, at least when taken in its 'chemical industry' meaning. In addition to the impact of well-known disasters such as Seveso, Bhopal or AZF, the focus is now on the widespread ecological and health risks associated with chemical substances in the environment (pesticides, glycol ethers, bisphenol A, etc.).

Public research would therefore appear to be concerned in several respects: as a group of people and institutions (major research organisations, universities, public bodies with industrial and commercial functions, etc.) with disciplinary and professional diversity (chemists, toxicologists, eco-toxicologists, researchers in the human and social sciences, etc.) that are called upon to fulfil a wide variety of roles and functions (designing new chemical compounds, assessing risks, conducting expert appraisals, studying societal behaviour in response to risks, etc.).

Below is a brief reminder of the main thrust of the REACH Regulation (IIA) in order to better appreciate the extent to which it intends to impose a new chemical risk culture and (IIB) to show what responsibility lies directly or indirectly with the scientific community. We shall then (III) formulate some more specific recommendations for public research institutions and their staff.

A. The REACH Regulation, designed to foster a new chemical risk culture

Only the general framework of the text will be outlined here, which essentially consists of two points: firstly, the REACH Regulation reverses the rationale that previously presided over the development and marketing of chemicals; secondly, it introduces a number of new procedures to foster a new chemical risk culture.

1. A reversal of rationale

The REACH Regulation is designed to ensure that by 2020 all articles, chemical substances and preparations[2] are produced and used "responsibly and with due care" so as to "minimise" their serious adverse effects on human health and the environment.

To this end, the Regulation imposes a threefold change in rationale:

- Firstly, while grounding the new chemical control policy in a precautionary approach, it aims to improve the means of predicting substance toxicity so as to foresee the harmful effects of chemicals as early as possible.

- Secondly, it "reverses the burden of proof". Previously, it was up to the public authorities to decide to carry out a risk assessment and, in the event of proven or probable harm, to ban the use of a substance. The REACH Regulation has reversed this rationale; now it is the responsibility of manufacturers and

[2] *REACH has a very broad scope. It covers not only individual substances, but also preparations (dyes, paints, etc.) and articles (clothing, furniture, electrical appliances, toys, etc.) containing them. However, it does not apply to substances whose uses are covered by other regulations, such as radioactive substances, medicines, food additives, biocides, cosmetics or non-isolated intermediates.*

importers to provide information on the risks associated with the substances they manufacture or import. Neither this regulation nor the precautionary principle requires proof of absence of risk, which is practically and epistemologically impossible to provide; but without data on the substance, it cannot be manufactured or marketed: the regulation stipulates "no data, no market".

- Thirdly, the REACH Regulation establishes the principle of authorisations and bans leading to the substitution of SVHCs by less hazardous chemicals when such an alternative is available at a reasonable cost.

Thus, not only does the REACH Regulation redistribute the roles between public authorities and industry, it also brings about a profound change by introducing a new approach to chemical risk management: far from being underestimated or tackled after the fact, once the hazards have been proven, risks must be foreseen as far as possible.

2. A broad range of new procedures

A whole series of procedures have followed this regulation, the implementation of which required the creation of a new body—the European Chemicals Agency (ECHA). Based in Helsinki, ECHA has been operational since June 2007. It has been given a central role, as it has control over the very core of these new procedures. In practical terms:

. all substances produced or imported in an amount exceeding 1 tonne/year must be registered with ECHA

Registration is the gateway to the system as it provides public authorities with a characterisation of the chemicals in circulation, and their impact on health and the environment. The authorities can thus identify those that will need to be further assessed and possibly lead to risk management measures.
The information required from operators—which they will have to compile themselves if it is not already available—varies according to the risks involved and the volumes produced or distributed: the more hazardous the substance (persistent, bio-accumulative and toxic, or even very persistent and very bio-accumulative) or the larger the quantities produced or imported, the more detailed the data that operators will be obliged to provide.
ECHA experts, currently being recruited from public institutions in the Member States, will decide whether or not to accept the dossier, or request further studies.

3. All "priority substances" are assessed

After registration comes assessment. Three key principles guide this step:

The principle of realism: given the practical impossibility of checking the acceptability of all the dossiers received, the Agency will study at least 5% of them. For in-depth assessments, it will give priority to dossiers on the chemicals of greatest concern (Art. 41.5.). ECHA must draw up a list of these substances and ensure it is kept up to date as new data are acquired.

The principle of delegation: as the Agency only has a coordinating role in the assessment process, it will establish this priority list in cooperation with the competent authorities of Member States. The MEEDDAT, which is ECHA's contact for France, entrusts AFSSET with expert appraisals. The experts from EU Member States will have the task of assessing the hazardous nature of a chemical substance on the basis

of existing data. They will also be required to inform the Agency and indicate which chemicals they wish to focus on for further assessment.

The principle of limiting animal testing: when the search for data requires the undertaking of tests that may involve the use of vertebrate animals, test proposals are submitted to the Agency, which ensures that the data in question cannot be obtained in any other way.

. *An authorisation is required for all SVHCs together with any substance that has highly dispersive applications or is produced in very large quantities.*
If it is not possible to quantify the exposure (dose and duration) of users, which is generally the case, the authorisation is only granted under two concurrent conditions: that there are no suitable alternative substances or technologies that are economically and technically viable and that it is demonstrated that the socio-economic benefits of the substance outweigh the risks. Authorisation is granted by the European Commission on a case-by-case basis and for a limited period of time, if the manufacturer or importer demonstrates that the risk is 'adequately controlled'.

. *Some very hazardous substances are banned outright; others, whose risk is not adequately controlled, are subject to specific restrictions on marketing and use.*
It is the European Commission that decides on this type of restriction on the basis of ECHA's opinion.

. *A system of data circulation and transparency between producers, importers, distributors, users and consumers has been set up.*
This is justified for two reasons. Firstly, the aim is to ensure that existing data are shared among manufacturers who have registered the same substances. The database (known as the "Substance Information Exchange Forum", SIEF) thus set up should make the registration system more efficient and less costly for companies, even though it is likely to raise sensitive industrial secrecy issues. Secondly, each player in the supply chain—manufacturers, importers, distributors, etc.—must be informed of the risks they run with the substances they are handling. Further downstream, the consumer must also be informed, through appropriate labelling, of related hazards and the precautions to be taken when using these chemicals.

B. Implementation of the REACH Regulation: a responsibility for public research communities

This overview might lead the reader to believe that public research communities are not directly concerned by application of the REACH Regulation, or at least only from an intellectual and societal point of view, as the text is primarily directed at players in the manufacturing and supply chain. Public research communities have in fact remained mostly on the side-lines of the debate, whereas in other fields concerning technological or natural risks, they have been involved, committed and structured to such an extent that the incentive to take measures to manage these risks has sometimes come from within the scientific community itself, or has been supported by it very early on.

However, the academic community of chemists and toxicologists is directly concerned, across the whole range of its disciplines and roles (design of new chemicals, verification and assessment of products and partnerships with industry, for example). This is actually the crux of the classic debate on the ethical obligation of scientists to be concerned about the uses to which their results are put. This obligation is all the stronger in the case of chemical substances, since interactions between fundamental science and

industry are very strong, and researchers are very concerned about the applications of their research. Chemists cannot claim that they are neither responsible for the products they help to develop nor for the risks to which their work may expose the public and the environment. Moreover, the very strong public reactions to chemical pollution, often perceived as an assault on and a condemnation of their work, cannot leave them unmoved. Although there are few toxicologists today, they will doubtless grow in numbers. It is important that they express their views and make their opinions heard.

1. Feeling involved in implementing the REACH Regulation

Without waiting for the forthcoming revisions, researchers in public institutions must now carefully monitor the regulation's implementation. In contrast to the transparency of the legislative phase, the text's actual implementation—which is a crucial step—could be an obscure and lobbied process. Since REACH aims to control the risks associated with current or future chemicals and thus to bridge the existing knowledge gap, it is logical that sound and independent scientific knowledge is needed to achieve this objective.

It is obviously the chemical industry itself, not the public research community, that is responsible for producing this knowledge. However, the effectiveness of such a system is questionable, given that the source of funding for assessments can directly influence their outcome[3]. Will ECHA and the national authorities have the means to properly supervise the studies carried out by industry? Whatever the answer, public researchers can play the role of counter-experts. Public research may thus be involved in the system in three ways:

Firstly, it forms part of the operational structures of ECHA, which has three committees[4] made up of scientists proposed by Member States, and also recruits experts seconded from the public institutions of each State.

Secondly, it pools resources that are available to the Agency. ECHA just coordinates the assessment process, and therefore relies on the scientific and technical expertise available in Member States.

Finally, public research must play its role in the enormous research effort required to find alternatives. This involves developing not only substitutes for banned or restricted substances, but also alternative methods to animal testing. The pace at which these alternative tests are validated by the competent European body must be quickened so that they can be reliably used throughout Europe.

More generally, the aim is to ensure that decision-making bodies can rely on in-depth scientific analysis. This shows the importance of having high-level, collective and adversarial national expert appraisals.

2. The need for sound expert appraisals

The many contemporary debates on scientific appraisal reveal that multiple expert appraisals are required[5]. Each case calls not for a single expert opinion but for a comparison of several opinions. In this context, public research has a new role to play: without claiming to be the ultimate arbitration body, it can harness

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[3] See, by way of an example, the studies on aspartame: Survey of aspartame studies: correlation of outcome and funding sources, Ralph G. Walton, M.D., The Center for Behavioral Medicine. http://www.dorway.com/

[4] Member State Committee, Committee for Risk Assessment, Committee for Socio-Economic Analysis.

[5] Report of the CNRS Ethics Committee: https://comite-ethique.cnrs.fr/en/documentation-2/ Symposium entitled "Les nouveaux enjeux de l'expertise scientifique" [The new challenges of scientific expert appraisal]: http://www.chimieetsociete.org/en/events/symposia/expertise-scientifique.html

high-level skills to provide credible support for the necessary dialogue between producers, researchers, users and decision-makers.

Moreover, it is not only in their power, but it is a duty for public researchers (whether chemists, toxicologists, biologists, epidemiologists, etc.) to engage in the debate on difficult subjects like risk assessment. Unlike in the case of medication—where the dose and level of exposure are determined by the prescription—data on diffuse environmental pollutants remain very imprecise, and the scientific discourse on the dose-response relationship pertaining to low doses is still wide open.

This duty is all the more pressing as the close collaboration between public research and industry may lead to questions about the independence of researchers. It is therefore essential to ensure that these close links do not lead to industrial or economic conflicts of interest influencing the experts' opinions.

3. Chemistry for sustainable development

The REACH Regulation aims to ensure that, in addition to assessing the risk of current chemicals, environmental and health safety requirements must be factored in to new product design. As they are being developed, their life cycle, recycling and dispersion in the environment have to be taken into consideration, as pointed out by the French *Grenelle* environmental round table among others.

Far from being the sole concern of industry, this imperative can obviously only be met if it simultaneously becomes an early priority in academic research laboratories, which must develop less polluting substances and—as COMETS has often stated in other fields—must address the risks and their acceptability from the research planning stage. Indeed, this is not only an ethical responsibility of researchers but also a "legal" obligation on the part of the State, since the environmental charter enshrined in the French Constitution provides for research to support environmental protection (Article 9).

This demand is beginning to be heard by the chemical community, which has set out[6] the "12 principles of green chemistry" specifying the means to be developed to meet sustainability objectives. These include using renewable raw materials, developing new synthesis methods needing fewer atoms (and therefore producing less waste) and less energy, and optimising processes. A charter committing the main players in the chemical industry to this approach has recently been signed[7].

A "Chemistry for Sustainable Development" programme, which aims to harness chemistry for sustainable development by supporting interdisciplinary fundamental research programmes that integrate this concept, was launched jointly by the CNRS Chemistry and ESD departments in 2006. It is a first step towards implementing these objectives. The effort in this area must be pursued on a long-term basis.

4. How much risk is society willing to accept?

In addition to risk assessment in the strict sense, researchers in public institutions can and should also help assess the acceptable risk[8] of chemicals. Such a task—which requires close collaboration between human and social sciences on the one hand and the natural sciences on the other—directly concerns an organisation like the CNRS.

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[6] *http://www.cnrs.fr/inc/recherche/programmes/docs/chimieverte.pdf*
[7] *http://www.ambitionchimie.eu/*
[8] *"Technical Guidance Document on preparing the Chemical Safety Report under REACH – Preliminary Guidance Document on preparing the Chemical Safety Assessment under REACH –Phase 1B (REACH Implementation Project 3.2-1B)".*

We know that sometimes contradictory requirements are applied when protecting human health and the environment. These arise because many different criteria are taken into consideration: in some cases, our society does not wish to do without certain articles that it values, even if they contain substances of concern that cannot be replaced; in other cases, a minimal risk is considered to be unacceptable because the article is not considered to be of interest, either technically or in terms of convenience. In practice, in the field of chemicals as in others, the level of protection of human health and the environment thus depends on the acceptability of the risks involved.

Contrary to what the notions of "threshold dose" or "limit" might suggest, science cannot mechanically set tolerance limits[9]. They must be determined on a case-by-case basis, by combining socio-economic criteria and ethical values that are too often ignored, including the following questions: What is the benefit to society as a whole of this or that chemical or the articles containing it? Can we choose to do without it or not? What would be the economic and social consequences? Are there any other options? How effective would they be, and at what economic cost? Is it advisable to run a proven risk from a collective point of view? How is this risk spread across different categories of the population and who benefits from it? Are those who are exposed to such a risk aware of it and do they accept it freely?

These socio-economic and ethical questions ultimately raise fundamental issues such as the value attributed to the quality of the environment and to human life. Even if such questions cannot be answered in a strictly scientific sense, they must be asked and carefully thought through.

Finally, whether designing non-toxic substances that meet the requirements of sustainable development, assessing chemical risk, or evaluating its acceptability, researchers are a link between science, industry, politics and society and must be there to support the profound change in rationale sought by the REACH Regulation. Their independence must be guaranteed by appropriate procedures in order to legitimise the trust placed in them.

5. Thinking ahead to future revisions

The REACH Regulation is far from being set in stone and periodic revisions of the text, incorporating new data acquired, are already planned.

Of all the questions raised, several are of paramount importance:
. will the regulation apply in the future to chemicals produced in quantities of less than 1 tonne (some of which can be very toxic)?
. should nanosubstances be subject to the regulation?
Theoretically, the REACH Regulation applies to all chemicals, but as most nanosubstances are produced in quantities of less than one tonne per year, they are currently exempt from registration; furthermore, they often belong to a family (that of carbon, for example) that is deemed to be risk-free and exempt from assessment. Should the regulation then be amended so that it explicitly covers all such substances,

[9] *F. Caballero, Essai sur la notion juridique de nuisance [Essay on the legal concept of nuisance], LGDJ, Paris, 1981 pages 70 and 236.*

making them subject to registration and assessment requirements because of the specific risks associated with their size?[10]
. substances manufactured or imported for Research & Development (R&D) purposes must just be notified to ECHA, and are exempt from registration for 5 years. Should the exemption of substances used in R&D be maintained?
. will the efficiency of the newly established administrative structures be evaluated, and modified if difficulties arise in implementing the regulation?

All these questions will be decided on by the European Commission following the proposals of Member States, which should logically be based on the opinions of public institutions. They must therefore be thought out by the latter sufficiently in advance of the planned revisions.

This is why, without taking sides on the scientific dimension of the issues at stake, this Opinion makes some recommendations on the ethical aspects they raise.

[10] *These are biological risks, as nanoparticles are so small they can cross the various biological membranes, and risks linked to the emergence of new properties resulting from the considerable increase in the surface-to-mass ratio of these nano-objects.*

III. RECOMMENDATIONS

The drafting of the REACH Regulation has revealed and crystallised many concerns, widely reported by the media, about the hazardous nature of chemicals. While the responsibility of public research players—individuals and institutions—is largely implicated in the implementation of REACH, they also have a duty, well beyond these regulatory aspects, to participate in the public debate on these issues, to be attentive to the concerns that arise, and to provide the answers in their possession. As Richard Ernst (1991 Nobel Prize Laureate in Chemistry) has pointed out[11], the ethical principles often invoked by decision-makers are rarely followed in practice. Scientists have a role to play in constantly reminding us of the ethical imperative.

The complexity of the problems raised requires that the expert appraisals undertaken be both collective and contradictory, and that they take into account "lay knowledge". They must be conducted with the utmost transparency and show where the limits of knowledge lie for each problem, without obscuring the uncertainties. In a field that is reputed to be opaque, and which has been marked in recent years by the withholding or even manipulation of information, the vigilance of researchers would appear to be particularly important. There is a need to watch out for misconduct in the name of optimisation, or falsification of data. One of the tasks of institutions is to ensure that both these requirements and a number of ethical values and rules of conduct are respected. It may include highlighting possible conflicts of interest—in particular when experts have relations with industry—and highlighting the ethical stakes of a given choice and supporting positions that give priority to the general interest.

COMETS has already proposed recommendations in previous reports on scientific expert appraisal and nanoscience and nanotechnology[12] that are relevant here and will not be repeated below. The specificity and urgency of the issues raised by the REACH procedure lead us to make the following specific recommendations.

1 - Claim a role for public research in the final scheme for assessing chemicals

The structures and stakeholders involved have been analysed above. The decision on the acceptability of registration dossiers rests with ECHA, which relies on its own experts. Is this a satisfactory situation? Will there be access to the arguments made? Care should be taken to ensure that the procedure gives an institutional place to academic research so that it can make its scientifically recognised voice heard, a voice that should remain independent from that of industry stakeholders and pressure groups insofar as possible. To this end, the fundamental research institutions of Member States could form a network that would intervene at ECHA level.

On a national scale, it would appear desirable for public research bodies to be present in the scientific bodies of AFSSET.

Within the CNRS, the creation of a standing unit to monitor the implementation of REACH, under the responsibility of the Institutes of Chemistry, Biological Sciences, Ecology and Environment, INSU and Human and Social Sciences, appears necessary. This unit would be the central point for identifying those laboratories competent in the knowledge required for the "proper" implementation of REACH; it could also

[11] *Angew. Chem. Int. Ed. 2003(42):4434-4439.*
[12] *https://comite-ethique.cnrs.fr/en/documentation-2/*

ensure the circulation of data and information from ECHA, allowing researchers access and enabling them to give advice in their field of expertise.

2 - Promote specific research

a) Within an interdisciplinary framework of chemistry, biology and environmental science

All the initiatives taken in support of sustainable chemistry must take REACH compliance very seriously. Upstream research staff must question the risks of the chemicals they discover, manufacture and handle, and disclose any problems they identify in a transparent manner. This requires close and systematic interaction with toxicologists and/or biologists. These concerns must be included right from the start of research projects. The development of predictive methods for toxicity and the search for substitutes for hazardous substances must be a constant focus.

Public research institutions should therefore encourage the development of fundamental research in chemistry, toxicology and eco-toxicology. These last two disciplines, in which there are few French research projects, are in particular need of strong support. Universities need to develop relevant basic courses. More generally, it is necessary to create truly multidisciplinary courses upstream of research, in this case at the interface between chemistry and biology. Concern about the effect of chemicals on health and the environment implies a minimum of knowledge about the mechanisms of toxicity, or a minimum of biochemical knowledge, allowing dialogue with life sciences.

In the short term and in order to address the urgency of the situation, specialisations should be offered to researchers already trained in biology, chemistry, etc. and the conditions needed for better interaction between these disciplines (schools, internships, joint research laboratories, etc.) should be created.

The idea of a national laboratory such as INERIS responding to requests from chemists and helping them predict or assess the toxicity of their products could also be considered.

b) Within an interdisciplinary framework with the human and social sciences

Given the nature of the problems posed, this interdisciplinarity should include the human and social sciences (HSS). Economists, sociologists, philosophers and lawyers should be involved and interact with the other scientific components concerned. It is up to them to reveal and clarify the issues at stake, to reflect on the knowledge needed for a cost/benefit calculation that truly takes into account ethical and not only economic issues and, in so doing, to help decision-makers better discern the options at hand. The resources needed for a specific HSS appraisal should be set up so that these disciplines are represented in the recommended monitoring unit.

3 - Train researchers in their obligations to society and their responsibilities

Raising awareness of scientific staff's societal obligations is a priority. The above institutions and recommendations will not be effective unless employees are implicated in a bottom-up approach. This concern should be present from university education onwards, as teachers have a responsibility to provide training that is sensitive to society's expectations. The CNRS should supplement and compensate for any shortcomings in this training for researchers in its laboratories, particularly during the thematic schools it organises.

It is also necessary to remind the academic scientific community that it has a duty to dialogue with all the opinion groups concerned by the debate (environmentalists, consumers, journalists, etc.) and to establish a

climate of trust with them. This implies providing accurate information on the state of science by communicating it to the general public, and by scrupulously showing both benefits and drawbacks. The community should also act as a watchdog, issuing warnings and being supported in this role by its institutions. Participants in debates should not be satisfied with unilaterally transmitting their own knowledge, but should take into account the knowledge, as well as the questions and "feelings" of their audience. Citizens claim the status of co-experts; they want to have a say in the questions posed to science and the means used to answer them, which is perfectly legitimate provided that a clear distinction is made between the registers and the times of the various contributions. In this context, new forms of dialogue need to be invented, which should be a stimulating objective.