Observe – Probe – Regulate

Embedding Nanotechnological Developments in Society

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Executive Summary

Research regarding the safety of nanotechnology has to contend with profound gaps in knowledge regarding the toxicity of nanomaterials. Its provisional aim, therefore, is to structure the field in a rather elementary way, including attempting to develop test procedures, standards and norms. A formally instituted means of regulation, such as setting legal thresholds, appears unachievable for systematic reasons.

However, the sustained focus on the toxicity of nanomaterials fails to do justice to the complexity and multiplicity of nanotechnologies and the associated demand for a comprehensive approach to ensure that nanotechnological developments are compatible with human, environmental and social health.

Drawing on an analysis of national and international approaches to regulation, this report outlines an institutional model that meets the safety and security demands of human health, the environment and society. It employs the methods of document analysis, expert interviews and a workshop with invited experts.

The results include the following points. The place of classical regulation has been taken by precautionary measures such as observatories, voluntary codes of conduct and stakeholder dialogues. By themselves, these cannot meet the challenges posed by nanotechnologies, nor do they satisfy the need for regulation. These soft measures of an expanded notion of regulation and precaution do not provide what classical regulation has to offer, namely public oversight, political transparency and legal certainty – guaranteed by a publicly accountable institution. A generalized precautionary approach thus also signifies a surrender of the political option of intervention. However, the option of influencing processes of innovation is indispensable for responsible, circumspect and socially robust action with regard to the uncertainties associated with emerging nanotechnologies.

These considerations call for a reflexive adjudication procedure as a collective learning process and as a means of earning public trust. This reflexive adjudication consists in an evaluation and contextualization of existing regulatory approaches that is politically transparent and open to public scrutiny. The way in which existing institutions and regulatory procedures deal with nanotechnologies is judged as more or less adequate with regard to public demands for knowledge, communication and effective action. A ‘scanning probe agency’ (SPA) is recommended as a suitable institution to organize such procedures of reflexive adjudication. It should be established under the auspices of a nationally and internationally respected academy of science.

Findings

'Nanotechnology' is an extremely multifaceted and complex phenomenon. Both the amorphous boundaries of 'nanotechnology' as an entity and the correspondingly varied safety requirements of products and production processes make it virtually impossible to adapt existing legal regulatory mechanisms. The limits to and gaps in knowledge are plentiful – including a lack of standards, characterization and testing procedures etc. – and pose a special challenge to safety research and regulatory measures. Attempts exist to make up for the systematic deficiencies in the legal regulatory system by means of 'soft' measures, such as continual observation of developments, industry self-regulation via codes of conduct, and multi-stakeholder dialogues intended to establish legitimation. However, such measures – guided as they are by a vague notion of precaution – are not capable on their own of meeting the challenges posed by 'nanotechnology' in any appropriate way. They are an attempt to transform ignorance into a kind of certainty. The phenomenon of 'nanotechnology' also confronts us with systematic limits to knowledge that cannot be overcome in a preventative manner. Many of the opportunities and risks associated with nanotechnologies will become manifest and quantifiable only in retrospect – in the course of product use.

The 'soft' measures associated with an 'extended' concept of regulation represent a departure from the principles of classical legal regulation. The latter include public oversight, political transparency and legal certainty and are guaranteed by a publicly accountable and responsive institution, permitting effective intervention. The 'soft' measures alluded to above, however, constitute a retreat from these principles, whereas the option of intervening in and influencing innovation processes is indispensable for dealing in a responsible and socially robust way with the uncertainties encountered in this new field of technology.

Given these considerations, a *reflexive adjudication procedure* seems both necessary and appropriate as a collective learning process and a means of generating public trust. This procedure would provide a means of contextualizing and assessing regulatory practice in a way that is both open to public scrutiny and politically transparent; its focus would be on what is required in terms of knowledge, communication and action, as well as on the scope and suitability of measures taken thus far in the context of an 'extended' concept of regulation. The outcomes of observations from the special observatories, 'code of good practice' procedures and stakeholder dialogues would all be integrated into such a reflexive adjudication procedure. Its guiding question would be: 'Is nanotechnology in good hands?'

The model

This report outlines an institutional model which we have called a *scanning probe agency* (SPA). It is conceived as a learning community consisting of experts from all the relevant spheres of society – academia, industry, the unions, churches, NGOs and consumers and so forth. The task of this community is to formulate judgments on selected nanotechnological

products, processes and discursive phenomena and to present these judgments in public, while also giving a clear indication of where the limits to existing knowledge lie. This form of adjudication – one open to public scrutiny – is designed to render desired nanotechnological innovation processes compatible with social well-being while maintaining a commitment to the principles of classical regulation such as public oversight, political transparency and the possibility of intervention. This would be guaranteed by the framework provided by a publicly accountable and responsive institution that enjoys broad social acceptance. The latter would elaborate recommendations that have undergone a process of social negotiation. Such recommendations might include, say, research support for desired innovations, or regulatory precautionary measures in the case of products deemed to give cause for concern.

The SPA is characterized by three basic functions:

- a *scanning function* for broadly surveying the field of scientific-technical developments and identifying those innovations, products and discourses that require clarification;
- a *probing function* for selecting specific issues and conducting communication about their various dimensions within a 'learning community of experts'; sample probings will be conducted by means of testimonial hearings (involving witnesses from research, official authorities, industry, etc.);
- an *agency function* for conducting public, court-like adjudication procedures, for intervening in debates and for devising socially robust recommendations that specify, for example, the need for action on the part of other regulatory authorities as well as deficiencies in research and communication.

The three functions can be summed up in terms of surveying the terrain, conducting hearings on selected issues and elaborating recommendations in a collective and publicly transparent manner. The problem in question is thereby placed within an overall context of the health-related, environmental and social implications of nanotechnologies. These are the functions that mark out the SPA's reflexive adjudication procedure from the models of observation, self-regulation and public engagement that are inappropriate, inadequate, or simply too weak for 'nanotechnology'.

The SPA itself fulfils no regulatory functions and conducts no research of its own; its aim instead is to derive new insights on the basis of selected case studies. Because this is the case, it is able to function with a slimmed-down level of staffing: a small full-time service team and a learning community in the form of a panel of honorary experts. Given the demands posed by integrating the required forms of expertise in a suitable way – using the format of the 'learning community' – and by adjudication procedures open to public scrutiny, it appears most appropriate to affiliate the SPA with a scientific academy of both national and international renown, ideally the new German *National Academy of Sciences*. The integration

of expertise and the intended effectiveness of its recommendations demand that the SPA be situated within a *national and international network* consisting of institutions and organizations that possess the knowledge needed for the learning process and from which experts can be recruited for the adjudication process.

In *practice*, SPA is distinguished by two modes of working:

1. a *normal case mode* in which learning processes and public adjudication procedures (including recommendations) are initiated and conducted – either in response to requests coming from society or according to the interests expressed by the participating experts – in relation to selected nanotechnological innovations, products or discursive phenomena (the period for working on a particular issue is about 12 months);
2. an *incident mode* in which the SPA is able to respond in a flexible and ad hoc manner to unforeseen externalities – such as controversial products, scientific disagreements or political protests. Here, the SPA assesses, for example, the effectiveness and appropriateness of measures implemented by the regulating authorities in cases of crisis (e.g. removing a harmful product from the market in response to cases of illness) and elaborates recommendations aimed at improving measures that might be taken in similar cases (the period for working on a particular issue is approximately 2 months).

Rationale

The need for an SPA arises from the following *diagnosis of relevant problems*:

- The term ‘nanotechnology’ is used to refer to a large number of products – cosmetics, antibacterial surfaces, sensors, nano-semiconductors, food additives, as well as misleadingly termed ‘nano-products’. ‘Nanotechnology’ (in the singular) does not refer to a particular technology but is a term that absorbs a whole range of societal visions regarding new technologies – as such, it is a communication phenomenon or discursive artefact. A reflexive adjudication procedure is therefore required that deals with everything that gets referred to as ‘nanotechnology’ and that requires differing forms of official authorization, observation or monitoring.
- Reliable product safety can not be guaranteed solely through the use of standardized and tested component materials (e.g. nanoparticles), given that small *production-related deviations* at various stages of the manufacturing process in themselves can introduce new uncertainties. The levels of fault tolerance established for products and their use can represent a spectrum of potential risks that can only be judged by means of greater vigilance applied throughout the life cycle of a product. A reflexive adjudication must make this circumstance publicly transparent.
- Problems that arise in relation to a specific product labelled as ‘nanotechnology’ may have an impact on *the way society perceives ‘nanotechnology’ as a whole* and everything associated with it. This is why an assessment open to public scrutiny is required

that ‘disentangles’ the different dimensions of selected products and simultaneously takes into account the way they are linked to the overall phenomenon.

- Since consumers encounter ‘nanotechnology’ only in *product-integrated form*, uncertainties arise in a variety of areas – e.g. the interaction between different kinds of nanomaterials and solid bodies in the product concerned, interaction with the product environment, variations in individual usage. Only a reflexive adjudication procedure is capable of learning from a synoptic presentation of all the various required forms of knowledge – from scientific knowledge to the knowledge implicit in user habits and knowledge of relevant ethical dimensions. This can form the basis for a socially robust adjudication in each instance.
- The perspectives from which a nanotechnological product is viewed – e.g. chemical-toxicological, materials science, epidemiological or occupational health views – influence perceptions of potential regulatory requirements. What is needed here is a reflexive *mediation between various forms of expertise and regulatory responsibility*. The generous promises and expectations associated with ‘nanotechnology’ by its visionary advocates prompt a corresponding demand on the part of society for an integrated examination of nanotechnology’s compatibility with human, environmental and social well-being.

The point of reference

The SPA model is intended as a response to the *Zukunftsforum Nanotechnologie* (‘Nanotechnology Forum for the Future’) envisaged by the *German Federal government* for considered, interdisciplinary dialogue, and sees itself as a contribution towards identifying appropriate funding initiatives. The establishment of an SPA would create an official institution in the *position of mediator* that is both responsive to public concerns and politically transparent and which, by means of its reflexive adjudication procedure, would be able to provide ongoing support for and critical assessment of, among others, the projects that are part of the *Nano-Initiative-Aktionsplan 2010*, such as the *Nano-Dialog* initiated by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry of Education and Research (BMBF) project *NanoCare*, the working groups of the Federal Ministry of Labour and Social Affairs (BMAS), the consumer protection measures instituted by the Federal Institute for Risk Assessment (BfR), as well as the public information activities of BMBF campaigns such as *Nanotruck*. The findings from these would be integrated into adjudication procedures and recommendations that are open to public scrutiny. This would meet the need for public monitoring and the possibility of intervention in innovations and regulation.

Objectives and requirements

The *large number of systematic limits to knowledge* and corresponding wide-ranging demands for safety and security on the part of society pose a challenge to regulatory measures for 'nanotechnology.' These cannot be tackled solely by observatories, codes of conduct, stakeholder dialogues or other measures of an expanded and softened conception of regulation. These are some of the dimensions we have identified with regard to systematic limits of knowledge:

- the multi-layered nature and variability of what is meant by 'nanotechnology' as a socio-communicative phenomenon;
- limits of standardization due to nanoscale sensitivities to even slight variabilities in the context of production;
- the entanglement of societal perceptions of specific cases (e.g. harmful products) with the phenomenon of 'nanotechnology' as a whole;
- limits to knowledge arising from complex interactions as nanotechnological components are integrated into products and products into user environments;
- dependence of regulatory authorities on particular perspectives such as chemical safety, technical function, industrial standards and norms.

All these dimensions present the legal regulatory authorities with difficulties they can not resolve. In addition, the measures associated with an expanded conception of regulation (observatories, codes of conduct, stakeholder dialogues) are overburdened by such fundamental forms of non-knowledge and systematic limits to knowledge. This is because these measures – guided as they are by a notion of precaution – are grounded in the assumption that knowledge gaps are temporary and merely epistemic, that is, that they can be overcome as science progresses and that positive, quantifiable and therefore certain knowledge will be generated.

The idea of observatories, mechanisms of self-monitoring and dialogue is to institute a form of permanent and ongoing vigilance that buys time for the acquisition of more comprehensive knowledge to which legal regulatory mechanisms can be adapted flexibly. The expectation is that this comprehensive knowledge will encompass not only scientific, technical and industrial facts but also economic interests, user behaviour, ethical concerns and so on. Given the existence of systematic limits to knowledge, observatories and the like function as open-ended measures based on permanent vigilance and are aimed at integrating ever new forms of knowledge. On the one hand, these measures continuously produce new knowledge that is able to feed into the actions of regulatory institutions. This knowledge is acquired, for example, in the course of efforts at standardization, through data collection required for the implementation of 'codes of conduct', or as the outcome of conversations between stakeholders in the dialogue processes. On the other hand, however, *new* gaps in and limits to knowledge also continuously become apparent in these projects, which in turn call into question the producers' claims to safety, security and certainty. This observation is not new and does not apply exclusively to 'nanotechnology'. Nonetheless, in a field of technology that unites so many

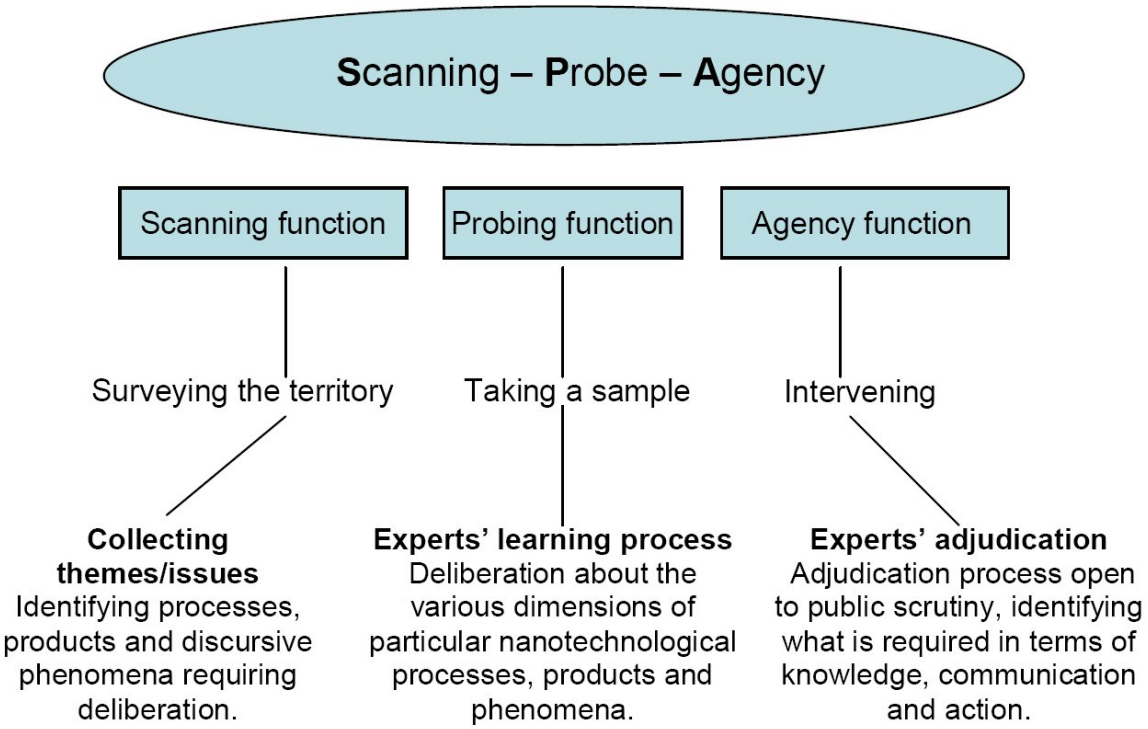
different production technologies within a single overarching concept, the systematic constraints of knowledge become multiplied.

If nanotechnologies are to be dealt with in a way that is socially acceptable and, as such, conducive to innovation, it is necessary to *integrate* the findings of the observatories, codes of conduct and stakeholder dialogues in the form of a collective, public and transparent *adjudication procedure* based on selected cases. The objective is to elaborate socially robust recommendations for regulation, research and communication by identifying what is required in terms of knowledge, communication and action. These requirements can be fulfilled only by a visible *authority responsive to public concerns* that brings together the *necessary areas of expertise*, suitable forms of *reflexive-learning dialogue, political transparency, public assessment* and *effective intervention* in a single institution.

For this purpose, we propose the establishment of a *Scanning Probe Agency* (SPA). This model consists of a learning community made up of experts from a diverse array of social spheres (including science, industry, unions, churches, NGOs and consumers). The objective of this community is to reach judgments about selected nanotechnology products, processes or discursive phenomena and, in doing so, to lay bare the criteria and difficulties associated with the formation of such judgments. This process of public deliberation can orient nanotechnological innovation processes towards conditions of societal acceptability and social well-being. The measures associated with 'expanded regulation' will be integrated into the reflexive adjudication procedure. They benefit from the procedure by being tied back into a stronger regulatory concept that holds onto the ideals of classical regulation, despite the deficiencies of legal regulatory mechanisms. [...]

Type and designation

The institution developed here is provisionally described as a 'Scanning Probe Agency'. Whether the choice of name is a happy one or not is an open question. That the designation is apt is beyond doubt, though – not least because it refers to an instrument that embodies nanotechnology as no other does, namely the scanning probe microscope, which not only observes but actively intervenes in the nanoworld. However, the designation is especially apt because it names the three basic functions of the model (see figure below):



Functions of the SPA

In its *scanning function* the SPA surveys the current nanotechnological landscape. This includes research trends, the marketing of new nanotechnology products and the state of debate within society as well as within the social and human sciences on the subject of 'nanotechnology'. In carrying out this task, the SPA makes use of the data and findings that originate within scientific specialities, or are collected by observatories or generated in the course of implementing codes of conduct (e.g. regarding the opportunities and risks associated with particular production processes). Its synoptic view of the field of 'nanotechnology' also includes media research and the reports emerging from dialogue processes. One aim of this *scanning* exercise is to reveal emerging issues and trends, characteristic or problematic case studies or potential problem zones. These might then deserve a closer look that can offer new insights or suggest novel ways of dealing appropriately with certain issues. The scanning function can also serve to identify patterns in seemingly disparate events and to establish connections in order to trace latent developments and create the necessary level of vigilance in a timely fashion.

The aim of the SPA's scanning activities, therefore, is not to create a complete and systematic collection of the widest range of knowledge possible, but rather to provide an overall picture of trends that require clarification and are significant in relation to different areas of society – such as the representation of nanotechnology in the media, demands for regulation by policy makers, risk analysis and safety research, product management and consumer protection, and concerns raised by unions, environmental organizations or churches.

There are two complementary ways of carrying out the work of identifying specific cases, problem areas or developmental patterns that require deeper understanding and sustained engagement. One is via the scientific staff of the SPA (‘scanners’), and the other consists of issues being brought to the attention of the SPA by way of specific inquiries from social actors – be they members of parliament, ministries or authorities, companies, advocacy groups or individual citizens.

When it then takes a closer look at the issues in question, the work of the SPA shifts to its *probing function*. Here, the SPA's broadly interdisciplinary expert panel turns to selected case studies and thematic areas for which there is a greater need for clarification and particular demand from within society. The experts form a *learning community* in which highly diverse forms of knowledge come together, including natural and social scientific knowledge, knowledge of production processes, knowledge about economic and investment issues, theological and ethical expertise, knowledge about work and safety issues and innovation processes, consumers’ knowledge of usage patterns. The learning process is characterized by collective knowledge acquisition in the form of informative exchanges among the members of the group but also in the course of court-like hearings. At these hearings, invited witnesses will be questioned about their experience in research laboratories, consumer protection work, regulatory processes or commercial enterprise and in their involvement in particular situations or events. This collective learning process feeds into the formation of a judgment by the expert panel.

Finally, in its *agency function*, the expert panel takes its findings into the public sphere and thereby intervenes in ongoing debates. It does so by presenting in a public forum not only the judgment reached by the learning community. It also shares with the public the various considerations and difficulties that were encountered in the course of the adjudication procedure. It will also present a dissenting opinion, should such exist. In this way, the knowledge and the questions that contributed to the deliberation of each specific case are rendered open to scrutiny, and a high degree of transparency is achieved. The judgment reached in each case may involve *recommendations* for scientific and social scientific research, policy, regulation and communication strategies. These recommendations from the SPA have no legal or otherwise binding status and do not overlap with the work of agencies that are already implementing existing regulations. As such, the SPA has a clearly delineated area of responsibility that encompasses everything associated with ‘nanotechnology’. The SPA has no formal powers, however. Its authority is based on the balanced composition of the panel of experts, on its publicly transparent judgment and its orientation towards relevant questions, and thus its ability to focus on critical concerns regarding opportunities and risks of nanotechnologies. In this respect, the SPA is comparable with the German government’s *National Ethics Council*.

Operational modes

Normal case mode

The members of the expert panel or the three ‘scanners’ on the service staff propose themes or issues in relation to which they perceive a need for greater clarity and which they believe are of particular importance to society. These themes may emerge either from their observations of nanotechnological developments and discourses, such as those made at the observatories or at stakeholder dialogues, or from experiences in their own area of work – or simply out of their own personal interests and expertise. These may be practical problems with regard to workers' health and safety, issues to do with the toxicity of certain substances, research programmes and visions, or statements concerning the role of precautionary measures etc. However, queries may also be put forward by parliamentarians, citizens or manufacturers. Where necessary, research on selected issues will be conducted by the service staff. Once these scanning activities are completed, the probers, together with the administrators on the service staff, will prepare the first annual meeting of the expert panel, at which suggested themes will be considered and one of them selected. The informed opinions offered by the members of the expert panel based on their various fields of work, along with their assessments of the importance of the issues in question, play an important role in this decision. The learning process thus begins with judgments regarding the salience of this or that technology trend, ethical concern, regulatory decision, funding initiative or media representation.

Once they have agreed upon the issue to be discussed, the members of the expert panel first exchange information with one another concerning the current state of knowledge, or gaps in knowledge, and current perspectives on the issue. They and the service staff propose ‘witnesses’ to be invited to the hearing, e.g. university researchers, representatives from industry, officials at government agencies etc. The hearing takes place in conjunction with a closed expert workshop at which a collective judgment is formulated that is subsequently presented to a larger public. These judgments contain assessments and proposals for research, regulation and communication.

Illustration of the scope of possible judgments:

- Assessments of the preparedness of regulatory agencies for dealing with the emerging aspects of particular innovations; judgments about the extent of their capacity to act, including suggestions for improvements in the implementation of regulatory guidelines.
- Recommendations to companies regarding appropriate measures (such as product labelling), in order to satisfy consumers’ real informational needs, that is, without producing a surplus of useless information that is available for any nanoproduct.
- Judgments about the extent to which certain promises or fears in an area of nanotechnology are justified or misleading, and establishing accountability for any visionary claims made on behalf of nanotechnology.

The judgments of the expert panel need not involve a consensus. Ideally they should include a majority and a minority opinion, in order to underscore the force of any particular judgment and to accentuate unresolved differences that are due to gaps in unequivocal evidence. A record of the judgment and the process leading up to it will be prepared by the 'probers' on the service staff and presented in appropriate form for subsequent public debate.

Immediately after the closed expert workshop, its findings, conclusions and the judgment itself will be presented in the context of a public event and opened up for discussion. The public forum, or conference, can be attended free of charge by interested groups. The chairperson of the expert panel will provide an informal account of the workshop and its adjudication process. The individual experts on the panel will present their (various) assessments that led to the judgment (majority and minority opinion). This serves to illustrate the difficulties and learning impacts encountered along the way. In this way they render the adjudication process transparent. They respond to questions and objections by participants in the public forum. This provides a last opportunity for the expert panel to examine its judgment in light of possibly novel considerations that emerged during the public discussion. The judgment is then finalized and made available to the media.

Incident mode

The aim of the SPA is to facilitate learning processes between different kinds of knowledge and expertise on the expert panel. This should occur not only in relation to the panel's own interests or inquiries from outside; rather, the SPA's reflexive adjudication procedure must also be able to deal in a *flexible* and *ad hoc* manner with the contingency of unintended and unforeseeable incidents. Cases such as the illnesses brought on by 'MagicNano' both constitute an 'incident' and trigger a 'regulatory crisis' among existing regulatory agencies. In such cases the SPA and the regulatory agencies can learn from each other's responses and recommended measures. However, the way in which an incident is addressed by the SPA is completely different from the way a crisis is managed by a regulatory agency. Measures taken by official authorities to avert danger and measures recommended in the course of the SPA's reflexive adjudication procedure should prove complementary with respect to particular incidents. For example, a case such as MagicNano is a good opportunity for the expert panel to examine subsequently what worked and what did not work as public agencies, the media and society at large dealt with this case.

It is possible to imagine various examples of incidents with which the SPA would concern itself. What they have in common is their ability to cause perplexity among both experts and the broader public, given the way in which fact and fiction are hopelessly entangled in nanotechnological development, as are knowledge and ignorance, issues of safety, security, certainty as well as more general socio-political topics, expectations of nanotechnology and actual experiences with nanotechnological products. Relevant incidents may thus have quite diverse *triggers*, as demonstrated by the following examples.

Example 1: Harmful product

In a case such as 'Magic Nano' the harmful product would be the externality that prompts the SPA to initiate its incident case mode. The SPA would analyse and assess the communication difficulties that exist between the various actors involved in the case. The SPA would have to bear in mind, for example, that although 'Magic Nano' is not a product that contains nanoparticles, it still counts as a 'nanoproduct' because 'nanotechnology' is a heterogeneous field of ill-defined product developments that include merely attributed characteristics.

As is well known, 'Magic Nano' contains no nanoparticles, but the thickness of the protective film produced by the cleaning spray lay in the nanometer domain. Clearly even the manufacturers were not aware that there were no nanoparticles in it – an episode that demonstrates how difficult it is to explore and control the world of nanoparticles and nanoproducts by means of routine technical or legal monitoring.

In such a case, the SPA's adjudication might point out that the responses of agencies and/or industry were highly effective and appropriate, but that a number of crucial questions were not addressed, such as those regarding the lack of transparency in the production and marketing chain – why, for example, was it so difficult for the various actors involved to determine the nanodimensions of the product? How could such a product obtain a 'TÜV' label (confirmation that the product has been officially tested and approved)? Why are there no suitable testing procedures in place for the purpose of awarding such a label?

Example 2: Scientific controversy

An incident could also be triggered by scientific controversies, contrary expert opinions or scientific promises communicated widely in the media.

It is conceivable, for example, that a new debate about nanoassemblers or irresponsible science could be opened up by a sensational media presentation that presents current research as a preliminary stage towards the creation of self-replicating nanomachines. The SPA's work here would consist in putting one-sided attributions into context, disentangling them and probing them for their serious and substantial content, in order to render visible the genuine problems that are articulated in such visions of out-of-control technology. It might be possible, via a reconstruction of the incident, to identify as the original trigger for such a controversy the propagation of a highly visionary cost-intensive medical procedure that makes use of nanoparticles. Research institutes, industrial companies and the media propagate the promise that this procedure will heal previously incurable diseases. Funding agencies and research policy makers subsequently provide generous grants for basic research on this procedure, even though the scientific methods and technical procedures remain extremely controversial. Scientific journalism then amalgamates the vision of self-replicating nanomachines and the fact of generous public funding, which may then lead to a blanket critique of both nanotechnology and national research policy.

In such cases the adjudication of the SPA could consist in disentangling the scientific, political, economic and other factors involved in the controversy. Also, the SPA's expert panel would judge who – including the scientists and journalists involved – might be held accountable for the statements that encouraged the discourse about the limitless possibilities of nanotechnology. In this instance, the adjudication could also contain recommendations for better ways of monitoring and communicating the criteria of national research funding.

Example 3: Political protest

A third trigger for an incident could be a political protest movement.

Such a case could be similar to the protest of the *Grenoble Opposition to Necrotechnologies*, which justified its demonstrations against the opening of MINATEC in June 2006 by reference to the expansion of a global-capitalist surveillance society. Nanotechnology was equated, for example, with the spread of 'intelligent cameras' throughout society in 'subcutaneous implants' and 'biometric systems', and was described as a 'blitzkrieg against life'.

The aim of an SPA adjudication in such a case would be at once to establish differentiations within 'nanotechnology' and to put the protest into context. For example, it would be necessary to identify where there are genuine data protection concerns arising from the nanotechnological refinement of sensors. It would be necessary to make the point that this innovation represents only a small part of nanotechnologies and that other applications could be more closely aligned with the goals of the protest movement. A differentiation would also need to be made as to whether such a protest should not be addressed elsewhere – not so much to the institution that came up with the scientific-technical innovation as to political institutions which may well define the situation that is the target of the protest. To put it succinctly: the SPA adjudication would have to take the protest itself seriously, in order to determine which of its aspects ought to be taken seriously with regard to 'nanotechnology'. This would enable such protests to be understood rather than simply being dismissed as irrational from the start.

The bottom line

The three functions of the SPA (scanning, probing and intervening) come together in the learning impacts that emerge from the reflexive adjudication procedure. They orient the SPA towards the indispensable ideals of public oversight, political transparency and the possibility of intervention by an open and responsive agency that provides the greatest possible legal certainty. In this respect, to institute an independent learning community is also a means of drawing the amorphous, heterogeneous and vision-laden phenomenon of 'nanotechnology' into the sphere of *governance* and thereby to establish trust among citizens in processes of innovation and in the regulatory regime. The *learning impacts* are primarily twofold:

1. By encountering the perspectives of their peers in the course of their adjudication procedure, *the experts come to know* the various assessments, approaches and experiences

that exist in the various spheres of society, such as scientific disciplines, industry, governmental agencies, consumer protection, environmental organizations, unions and churches. This encounter with different forms of knowledge feeds into the joint adjudication process. Thus, the adjudication is not only a matter of assessing scientific-technical background information but also a matter of appreciating its social and cultural significance. Citizens' representatives learn from scientists and engineers, while researchers and developers for their part learn something about society's traditional values and concerns. Accordingly, the reality represented by the adjudication is rendered multidimensional.

2. The openness of the adjudication procedure to public scrutiny renders the individual steps transparent, facilitating *understanding and critical assessment*. This distinguishes the work of the SPA fundamentally from the mere provision of information by observatories and other measures of expanded regulation. The interface between expert knowledge and public interest should not consist in a database, an information event or an expert report, but rather in a process of adjudication that is rendered transparent. Any interested citizen can find out how difficult it is in a situation of fundamental uncertainty and a proliferation of public statements to find a responsible way of dealing with the opportunities and difficulties that arise in the emerging field of nanotechnology.

These learning impacts can engender *public trust*, although such trust entails far more than a set of consumer protection measures. Trust includes confidence in political processes and the governability of the emerging technology. This means that the concerns of the general public need to be taken seriously first of all – a fixation on health and environmental risks is not sufficient. Matters of civic concern include more generally the compatibility of a new technology with human health, the environment and social welfare. These are related to issues of justice and solidarity as well as national and international security, but also to a fair and responsible expenditure of state funds. Citizens' concerns should be taken seriously by doing more than merely informing various publics and eliciting their opinions. Beyond this, the SPA invites citizens to participate in the difficult process of adjudicating an issue.

By generating both learning impacts and public trust, the SPA can contribute to a culture of 'risk preparedness'. This consists in the willingness to accept unknowns for the sake of real benefits, and involves a circumspect attitude towards knowledge gaps that cannot be closed. Without the ability of our societies to distribute the burdens of ignorance and vigilance equally among their citizens, nanotechnological innovation will be unlikely to take root.