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Deliberating Risks Under Uncertainty: Experience, Trust, and Attitudes in a Swiss Nanotechnology Stakeholder Discussion Group

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Abstract Scientific knowledge has not stabilized in the current, early, phase of research and development of nanotechnologies creating a challenge to ‘upstream’ public engagement. Nevertheless, the idea that the public should be involved in deliberative discussions and assessments of emerging technologies at this early stage is widely shared among governmental and non-governmental stakeholders. Many forums for public debate including focus groups, and citizen juries, have thus been organized to explore public opinions on nanotechnologies in a variety of countries over the past few years. In Switzerland the Centre for Technology Assessment (TA-Swiss) organized such a citizen panel in fall 2006. Drawing from an ethnographic study of this panel called ‘publifocus on nanotechnologies, health, and environment’ this paper looks at the ways members of a stakeholder group deal with the epistemic uncertainty in their deliberation of nanotechnologies. By exploring the statements of the participants in the stakeholder discussion group, this paper reconstructs the narratives that constitute the epistemic foundations of the participants’ evaluations of nanotechnologies.

Keywords Citizen panel · Nanotechnology · Upstream public engagement · Risk · Uncertainty

Introduction

In the fall of 2006, a citizen panel on nanotechnologies was organized in Switzerland with the aim of exploring the opinions and attitudes of the Swiss population toward emerging nanotechnologies. Since Switzerland is one of the countries with the largest investments in nanoscale research worldwide,¹ the Swiss government has been – along with many other governmental and nongovernmental institutions – interested in knowing more about the visions and concerns of the public regarding nano research and its applications. Still sensitized by the intense social response to (green) biotechnology, governmental authorities and other stakeholders involved in the advancement of nanoscale research have been keen to avoid a repetition of the heated discussions and political consequences that had occurred. Today many of the stakeholders consider it a mistake that the public was informed about biotechnological innovations at a late stage of R&D when products and applications such as genetically modified food were already on the market. The consensus that the public should be involved in deliberative discussions and

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¹ In a survey of the European Commission, Switzerland is listed 17th for the largest public expenditures in nanotechnology worldwide [1]. Taking the funding of the private industry into account as well, Switzerland’s investment in nanoscale research is very large.

assessments of emerging technologies at a much earlier stage of technology development is widely shared among governmental and nongovernmental stakeholders. The citizen panel on nanotechnology initiated by the Swiss Centre for Technology Assessment (TA-Swiss) is an expression of this internationally shared concern to ‘upstream’ public engagement. The concept of ‘upstream engagement’ has been used by UK researchers [e.g., 2–6] and promoted in the UK Royal Society and Royal Academy of Engineering’s report on nanotechnologies [7]. In recent years, the “commitments to ‘upstream’ public engagement in processes of scientific-technological innovation are a significant shift in public-policy discourse” [4, p. 277].

Moving the science-society dialogue upstream, however, includes the challenge of coping with the epistemic uncertainty regarding the future developments and potential impacts of emerging technologies. This article analyzes the Swiss citizen panel on nanotechnology under this perspective. It focuses on how participants assess and evaluate nanotechnologies and their risks in a situation that is characterized by the absence of stabilized scientific knowledge. By exploring the statements of stakeholder representatives made in one focus group, the article reconstructs the narratives that constitute the epistemic foundations of the participants’ evaluations of nanotechnologies.

Risks, Uncertainty, and Public Knowledge: An STS Perspective

Constructivist studies of science have pointed to the negotiated character of risks, uncertainty, and knowledge which are not ‘given’ facts but socially shaped categories. Following the concept of ‘civic epistemology’ suggested by Sheila Jasanoff, knowledge on emerging technologies is generated collectively involving all different stakeholders and considering them as members of a civil society which by institutionalized practices test and deploy knowledge claims used in collective decision-making processes [8, p. 255]. A distinction between specific stakeholders or experts, on one hand, and ‘the public’, on the other hand, is thus a socially produced demarcation. The participants of the *publifocus* can thus be seen as members of a general public when confronted with nanotechnology research.

Nevertheless, a distinction between science and ‘the public’ has been maintained in many Public Understanding of Science (PUS) studies. Early (large-scale) studies had pointed to a lack of scientific literacy of ‘the public’ to explain the negative social responses to some science. In such studies, the public was seen as a population of passive consumers and recipients of science that were quite ignorant about expert knowledge. Such a view was criticized to be a ‘deficit model’ that was insensitive to local contexts and was not appropriate to grasp the heterogeneous knowledges of laypeople and the ways they perceive and evaluate science [2, 9, 10]. As a result of this critique a range of qualitative field research studies have been exploring how people in various social contexts experience science and make meaning of expert discourses [e.g., 11–13]. They have revealed ‘the public’ to be a construction of experts [14, 15] and have identified trust in scientific institutions as being a key issue of laypersons’ uptake of science [16]. The analysis of citizens’ responses to science has thus shifted from a lack of scientific knowledge to a lack of trust in scientific institutions and to the construction of lay knowledges.

In this article lay knowledges come into play in the narrations of participants. Such knowledges or understandings can be seen as constructed epistemologies that merge different forms of knowledge such as scientific, everyday, and tacit knowledge. In their assessments of nanotechnologies citizens draw on these incorporated knowledges that constitute their schemes of perception and interpretation.

The Swiss Citizen Panel on Nanotechnology

Participatory Technology Assessment in Switzerland

The Swiss Centre for Technology Assessment (TA-Swiss) has developed three instruments to initiate and facilitate public discussion of emerging technologies [17]. Like other citizen juries the Swiss model of *PubliForum* is inspired by the Danish consensus conferences that were introduced in the 1980s. A *PubliForum*’s ‘Citizen’s Panel’ usually consists of approximately 30 individuals who are selected on sociodemographic criteria. The panel gathers four times. Experts are selected by the Panel and are present during the third meeting to answer pre-

prepared questions. The last meeting focuses upon the (controversial) information given by the experts, and allows time for participants to formulate their recommendations – which are later passed on to the Swiss Parliament. *PubliForums* have been held on topics such as biotechnology and nutrition, organ transplantation, and research on humans.

The *publifocus* normally includes several focus groups, each of which have 10–15 generally randomly selected, individuals. Occasionally, some groups consist of representatives from specific interest groups. The focus groups gather for half-day seminars to discuss issues. In contrast to the *PubliForum*, the *publifocus* often includes a stakeholder group in addition to several citizens' groups. The *publifocus* thus aims to learn about the attitudes of both stakeholders and other citizens. *Publifoci* have been organized on issues such as in vitro fertilization, embryonic stem cell research, road pricing, and – as I explore in this article – nanotechnologies.

The smallest instrument of the public forums is the *PubliTalk*, which involves an afternoon discussion between experts and laypeople, the latter usually creates a homogeneous group in terms of age or professional background. The *PubliTalk* aims to reveal the opinions of the individuals. The findings resulting from the group and plenary discussions are summed up in a report written by the organizers.

Following the perspective of TA-Swiss the purpose of all three discussion forums is to keep the decision makers informed about the attitudes of citizens towards a specific technology and furthermore to make the views of laypersons part of the assessment of emerging technologies.

The Publifocus 'Nanotechnology, Health and the Environment'

In September 2005, the Steering Committee of TA-Swiss decided to organize a *publifocus* on nanotechnology and its impact on health and the environment [18]. Despite the rapid development of research and applications in this field, and the huge financial investments made in Switzerland and abroad in this sector, there was only little public awareness regarding the activities in the field of nanoscale research in Switzerland at that time. However, internationally several reports had pointed to some critical aspects of nanotechnologies [e.g., 7, 19, 20], and citizens' juries

and focus groups had been carried out in: Madison, WI, in April 2005; in New Zealand, from June to September 2005; and in the UK, from the spring to fall of 2005 [21–25]. Motivated by such initiatives and convinced that “[any] legislation that may be necessary... must also take the views of the population into account,” [26] TA-Swiss launched a discussion forum on the potential impacts of nanotechnologies on health and the environment, and it chose the method of *publifocus* in order to include both stakeholders and laypeople in the debate. The discussions aimed to reveal the different opinions of stakeholders and other citizens regarding the acceptability and desirability of nanotechnologies. The project description pointed to the following questions:

“How do so-called ‘laypersons’ perceive the nanotech debate? Where do citizens see opportunities for themselves, their health and the environment? And where do the possible risks lie? Does nano-research exceed ethical boundaries? Is there a need for regulation or a standardised declaration?” [26]

The *publifocus* was intended not only to contribute to increased public awareness and inform further debate, but also to help decision makers in assessing nanotechnologies [27, p. 8]. The *publifocus* was supported by other institutions² and assisted by a supervisory group that consisted of scientists and experts from other fields such as the industry. These persons were not present when the focus groups met but were involved in preparatory work, for example by giving advice on which issues should be discussed. The citizens were recruited by a random procedure. About 10,000 persons, whose addresses had been bought from a major direct marketing-company, were contacted by a mailing and invited to declare their interest to participate in the *publifocus*. Among the approximately 300 people who answered approximately 70 were chosen depending on their age, gender, profession, political activities (if these were declared), and place of residence. This procedure did not aim at selecting a representative sample of the Swiss population in statistical terms, but at choosing

² These were the Federal Office of Public Health (FOPH), the Federal Office for the Environment (FOEN), and the Zurich University of Applied Sciences Winterthur (ZHW).

different people with diverse socioeconomic backgrounds. The selected persons were divided into four focus groups which each should include a diversity of socioeconomic profiles. An additional focus group – which I explore in this article in greater depth – was a special group since it consisted of representatives from different interest groups, ranging from science and the industry to farmers' associations, consumer organizations, and other non-governmental organizations (NGOs). This group was recruited by contacting all Swiss associations involved in the production, distribution, or consumption of nano products. Among the 33 associations that were asked to participate in the discussion group 16 representatives showed interest.

In September 2006 the focus groups met in the various Swiss cities in different language regions for meetings of 4 h each.³ The procedure was always the same. After having been offered some drinks and food the participants were welcomed and instructed on the focus group procedure. The moderator, most often a journalist, initiated the discussion by asking the participants about their experiences with nano products in their daily life. The participants had already been provided with an information brochure on nanotechnologies that was written by a journalist on behalf of TA-Swiss [28]. After this first discussion round two experts gave short presentations; the first from a scientific and the second from an ethical or sociological point of view. The moderator then followed a guideline with further questions, most of them regarding the fears and hopes associated with nanotechnologies. The discussions were recorded in writing and summed up in a final report [29].

Focusing the *Publifocus*

Announced as a researcher studying the *publifocus* and interested in the public perceptions of and engagement with nanotechnologies, I was admitted as an observer of the meetings. The following analysis explores the meeting of one focus group – the group that consisted of 16 representatives of

specific interest groups.⁴ Most of the represented organizations had not, at that stage, established policies on nanotechnology. The representatives not only spoke as representatives of their organizations but also were asked to express their opinions as individuals and citizens.

Drawing on my observations of the discussions in that meeting I reconstruct the arguments, opinions, and evaluations of nanotechnology in the narration of the participants. I am specifically interested in the ways in which participants argue in a situation that is characterized by uncertainty regarding the potential risks of nanotechnology. In such a situation when scientific knowledge is scarce and controversial one might assume that the information brochure, the experts' presentations or the moderator's agenda-setting, were shaping the ways people perceived and evaluated the technologies. Such information is merged with participants' everyday knowledges. In this article I do not focus on interactions between experts and laypeople (there were only very few during the *publifocus*), or on how participants assimilated what they heard from the experts and read in the brochure, instead I explore participants' narrative structures and argumentations after their exposure to different knowledges.

The information participants were given seemed to be well-balanced. The information brochure [28] was specifically addressing laypeople and explained in a comprehensive way state of the art research. The brochure mentioned already existing nano products and potential future applications but also pointed to

⁴ The represented groups were the Associazione Consumatrici Svizzera (ACSI; Swiss Association of Consumers), Economiesuisse (Federation of the Swiss Economy), Föderation schweiz. Nahrungsmittelindustrie (FIAL; Federation of the Swiss Food Industry), Greenpeace, Konsumentenforum (kf; Consumers' Forum), Schweiz. Bauernverband (Swiss Farmer's Union), Schweiz. Gewerkschaftsbund (SGB; Swiss Federation of Trade Unions), Stiftung für Konsumentenschutz (SKS; Foundation for Consumers' Protection), Swiss Chemical Society, Swiss Mechanical and Electrical Engineering Industries (Swissmem), Textilverband Schweiz (Swiss Textile Federation), Schweiz. Vereinigung zum Schutz kleiner und mittlerer Bauern (VKMB; Swiss Association for the Protection of Small and Medium Farmers), and Verband Schweiz. Lack- und Farbenfabrikanten (VSLF; Federation of Swiss Varnish and Color Fabricants). All citations in the following quotes are from these *publifocus* participants; they do not necessarily represent the official voice of the respective organizations.

³ The cities were Winterthur and Bern (in the German-speaking part of Switzerland), Lausanne (in the French-speaking part), and Lugano (in the Italian-speaking region). The meetings took place either in a school or in a conference location of a hotel.

some critical points regards to safety aspects, social implications and potential risks, that had also been raised by various international reports. It neither privileged potential positive nor potential negative consequences of nanotechnologies. The guideline developed by TA-Swiss to structure the discussion was well-balanced raising hopes, fears, visions, and risks of nanotechnologies and did thus not impose a specific perspective on participants. The experts were either researchers from the field of scientific risk research, and were thus quite aware of the potentially problematic effects of nanoparticles, or were academics engaged in the investigation of the ethical and social implications of nanotechnologies. The experts thus had a genuine interest in both the development of nanotechnologies, and the monitoring of their potential problems. Their short presentations included a discussion of potential applications, risks and social implications of the emerging technologies but did not – in contrast to the Nanojury UK [23] – give any advice or recommendations on how the technologies should be handled. As we will see later, the participants suggested different ways of governing nanotechnologies and argued by drawing on heterogeneous narratives. This suggests that the experts' presentations did not have a determining effect on participants' opinions.

By organizing the *publifocus*, and raising both promising and critical issues about nanotechnologies, TA-Swiss demonstrated that it is willing to comply with its official mandate by considering the social, political, and environmental implications of emerging technologies and by including the public in deliberative processes. However, the *publifocus* reconstituted a demarcation between experts and 'the public' and it remains questionable if 'the public' were really involved in 'upstream engagement'. Nevertheless, in this article, I do not discuss the *publifocus* as a method of technology assessment, but have a close look at the ways participants argue in their assessment of early technological innovation. On what epistemic grounds do participants draw their evaluation of emerging technologies, when scientific knowledge is scarce and controversial? Based on my empirical findings I follow the assumption that in a situation of epistemic uncertainty and controversy citizens draw on their general and everyday, habitualized, schemes of perception and interpretation [30] and on their experiences to assess emerging technologies. As I will show this

attitude is not an effect of a general distrust in science or skepticism toward scientific institutions as we could assume following many studies on the public acceptance of biotechnology and genomics [e.g., 31–34]. Instead, it can be seen as a compensation strategy of the evaluating participants especially when scientific knowledge on potential impacts is scarcely available (especially at an early stage of R&D) or highly controversial.

Analyzing the Stakeholder Group

Defining Nano: What Is the Object?

When citizens discussed nanotechnology it became particularly evident that the participants did not share a general distrust in science, but at this early stage of the deliberation process rather desired further scientific knowledge. Most participants claimed that 'nanotechnology' was not a clearly defined object and that it was necessary to define the technology more precisely in order to be able to better assess it. The scientific experts in their presentations gave a mere technical definition of nanotechnologies, defining them as materials and structures at a scale between 0.1 and 100 nm. The information brochure, however, underlined that "[in] practice... 'nanotechnology' is not precisely defined" and mentioned that in several definitions of nanotechnology size was not the only criterion; instead the term included as well novel physical or chemical properties or was applied to synthetic nanoparticles exclusively [28, p. 1]. Nevertheless, all these definitions referred to scientific criteria, stakeholders, however, referred to more than just technical terms. The delegate of the textile industry, for example, pointed to the selling advantages of the notion nanotechnology. He was convinced that many products are labeled as nano products, although in fact they were not nanotechnologies:⁵

There are people who are good in marketing. However, ketchup and water-repellent textiles have nothing to do with nano. (*Swiss Textile Federation*)

⁵ All statements, originally in German, are translated into English by the author.

This representative – who applied a contested definition of nanotechnologies when claiming that ketchup and water-repellent textiles had nothing to do with nanotechnology – was convinced that “nano sells”. Another participant, the representative of the food industry, supported the view that nanotechnology had to be understood as well in terms of a marketing instrument and pointed to the missing definition of nanotechnology as a legally binding concept:

Nano is not a protected notion. You can find the notion anywhere as, for example, in the nanopod. (*FIAL*)

Implicitly, this statement also points to the metaphorical use of the term nanotechnology for cutting-edge innovations. Facing such heterogeneous meanings, participants deplored the lack of clarity of the notion – and thus of the object of discussion. For example, a representative of the machine industry said:

We need a clarification about what nano is. The notion is not secured. (*Swissmem*)

Similarly, a delegate of an NGO argued:

[One] has to define it very carefully. We have to know what we are talking about.... But first we have to clarify what it is. (*Greenpeace*)

Most participants shared the opinion that it was simply not clear what exactly they were talking about. They strove for a more precise definition of the notion nanotechnology, which in their opinion has to be assured by science:

We first have to define what nano is. This is, of course, a task of science. We need tests. If we don't know what it is, we cannot take any regulatory measurements. (*Swiss Chemical Society*)

The view that the definition was “of course” a task of science was not contested among the discussants. The delegates of civil organizations shared this view:

If we do not know exactly how to define *nano*, how should it then be declared or labeled? We first have to define what it is. We need much more research on this. (*kf*)

In the view of the participants, only if “much more research” is done – in other words, if scientific knowledge increases – nanotechnologies can be

defined and assessed, and appropriate measures taken. This suggests that the actors do not distrust nanoscientists in general but rather strive for more scientific knowledge to better define both the object and its potential impacts on health and the environment. It is interesting that this view seemed to be unanimously shared among participants. Although, one of the invited experts, an ethicist, suggested in regard to the precautionary principle scientific knowledge on a technology was not relevant. Nevertheless, the participants considered further research on nanotechnologies and its risks as necessary.

Visions for the Future: Expectations, Fears, and Hopes

A second issue underlines the rather positive attitudes of the participants toward further research in the field of nanoscience. When asked about their visions, fears, and hopes regarding the future of nanotechnologies, concerns and hopes were mentioned almost equally. The participants were invited to rank these on a scale from 1 (very low) to 10 (very high). While concerns ranged from 3 to 9, with an average of more than 5, hopes were rated higher and reached an average of 6, although they spanned the same range of the scale. Most people's hopes referred to new possible achievements in medicine, as this quote from a member of the consumers' forum illustrates:

In the medical domain, research has to be advanced. I am convinced that nanotechnologies will bring positive results there. (*kf*)

Her colleague agreed that “medicine is in the first position when it comes to visions,” as did others, like the Professor from the Swiss Chemical Society, and the representative from Greenpeace, who hoped that specific medical applications such as advanced prosthetics or nano-administration of pharmaceuticals will become possible. Many participants also revealed expectations regarding the particular properties of materials that are produced with nanotechnologies, such as self-cleaning window glass or building façades. As “shower partitions which show no water spots and stainless steel kitchens which show no fingerprints” were mentioned in the information brochure as already being available [28, p. 6], some of the participants indicated they were looking forward to further advances in this particular applica-

tion of nanotechnologies. With a wink of her eye, a woman from a consumers' organization explained:

If I'll have to clean up less, that is wonderful.
That will also help the environment since I will
need less cleaning agents. (*kf*)

The Greenpeace delegate also expressed hopes that nanotechnologies might contribute to environmental protection in the future, for example by enabling people to excavate oil spills or clean waters. The delegates of Economiesuisse (the federation of the Swiss economy) and of the trade unions pointed to the potential of nanotechnologies to create jobs – a vision that was also expressed in the UK citizens' jury [23, p. 174].⁶

The fears that were mentioned about future visions and scenarios mainly concerned the human health. The representative from the trade unions, for example, stated:

I can as well imagine a horrible scenario. Perhaps my successor at the workplace will have to deal with the 'nano tube lung' as a new disease of employees. (*Swiss Federation of Trade Unions*)

Some critical sentiments were voiced concerning the long-term effects of nanomaterials on the environment. Nobody, however, mentioned 'grey goo' as it had been expressed in response to early research on nanotechnologies [36]. The visions imagined by the participants were not drawing on any science fiction or utopias but were rather pragmatic and aligned with the products that already exist on the market and the information given in the brochure and provided by the invited experts. In other words stakeholders referred to already realized solutions and products or they formulated their visions according to what has been indicated as possible developments of nanotechnology applications in the information brochure or in the presentations of the experts.

It is interesting to note that there were no fundamental contrasts in the participants' visions. Al-

though the focal points of the participants statements differed according to their employment background, and their fears and hopes were not equally evaluated, the participants in general shared a rather hopeful attitude towards the development of nanotechnologies. As in the UK, participants did not solely highlight negative consequences or concerns about risks [23], nor did they reject nanotechnologies altogether, but rather they expressed hopes that the emerging technologies of the future will be able to make major contributions to medicine, to the workplace, and to daily life.

Risk Perceptions: Assessing the Unknown

While there was a relative consensus on the deficiency of a suitable definition for nanotechnology and for future visions of it, the participants disagreed when discussing the potential risks and impacts of nanoparticles in greater detail. However, most of the individuals were rather ambivalent towards nanotechnology risks, as expressed by the delegate of the Swiss Farmers' Union:

I do trust and I do mistrust [nanotechnologies]. I have major concerns regarding the health effects. (*Swiss Farmers' Union*)

A similar attitude regarding the emerging technologies was also expressed by an industry representative:

One can have confidence in today's [nanotechnology] products. But the health aspects are unclear. (*Federation of Swiss Varnish and Color Fabricants*)

While the participants from industry defended the safety of the products available on the market today they were not convinced that nanotechnology would not have any harmful effects in the future. The attitude of the trade unions was – astonishingly – quite similar to industry, for their representative did not criticize current nanoapplications but pleaded for a protection against future developments. For example:

The train is already moving, and we are riding it. We have to find barriers so that people will not get run over. (*Swiss Federation of Trade Unions*)

Drawing on the lecture of the invited researcher from EMPA – a Swiss research institute which is also engaged in risk research on nanomaterials – the

⁶ Similar visions have been expressed in science policy and in the media. The Swiss Federal Institute of Technology (ETH), for example, criticized the financial restrictions imposed by the Swiss government, which might result in losing Switzerland's current position in the field of nanoscale research. A newspaper commenting on this criticism wrote that the budgetary restrictions would thus "just affect a domain that will create new jobs in a few years" [35, p. 41].

representative of the foundation for consumers' protection agreed, in general, with concerns regarding future nanoapplications:

Nobody really knows. The EMPA's research results demonstrate that there are realistic concerns. It could have very negative effects. Nobody knows what effects it could have on the brain. (*Foundation for Consumers' Protection*)

The Professor of chemistry agreed. Due to the lack of scientific evidence, his attitude was also precautionary:

We cannot absolutely exclude that there lurks any danger somewhere. Regarding the unbound nanoarticles, the problem is even much bigger. I cannot reject that these particles will be dangerous. We have to find a balance between the smallest possible risk and a prohibition. (*Swiss Chemical Society*)

The Greenpeace activist was no more critical than other participants of the discussion; not rejecting nanotechnologies in general, but pointing to the ways in which they are deployed:

It is not a simple yes or no question. It depends on who will use the technology and what it is used for. (*Greenpeace*)

Risk Narratives: Progress, Life Attitudes, and Trust

Scientific evidence regarding the future effects of nano-risks, was, as we have seen, scarce at the time when the *publifocus* was organized. How then did the participants argue in support of their evaluation? On what epistemic grounds did they draw when assessing the emerging technologies? Three narratives can be distinguished, all of which are part of the general schemes of perception and interpretation of the participants: general views of humankind and historical progress, individual life attitudes, and trust in the political system.

General views of humankind were, for example, a reference point for the Professor of chemistry. He is confident that "humanity is certainly precautionary enough to not accept everything." The Professor is convinced that what he considers a precautionary behavior of 'humankind' has been beneficial in the past:

I think we should be active in research and should not wait. You never know everything. So

far, humankind has been doing well proceeding like this. (*Swiss Chemical Society*)

Similarly, the representative of the Swiss economy argued by embedding his narrative in historical dimensions:

Technological progress has always advanced us. A society has to be willing to bear certain risks. Otherwise, the chances will be taken by other societies. (*Economiesuisse*)

While many science and technology studies (STS) scholars have argued against technological determinism – i.e. against the idea that technology drives society – [cf. 37, 38] the representative of *Economiesuisse* sees nanotechnologies as a potential engine of historical progress. Such general views of a precautionary humankind and of the role of technology for the further advancement of societies comprised one form of narrative the participants drew on to make their argument. Another narrative referred to individual *attitudes toward life*. The representative of the Swiss economy declared:

I stand for a healthy optimism. We can see how it goes and if we will have to take any measurements in the future (*Economiesuisse*)

The importance of an optimistic view was also emphasized by the delegate from the textile industry:

Nanotechnologies are *in stato nascendi*. We need a healthy optimism. (*Swiss Textile Federation*)

This evaluation mirrors the participants' generally optimistic attitude towards life, as declared in their statements.

Finally, several participants drew on a narrative of *trust in the political system*. They were convinced that the existing regulations are rigorous enough to avoid any damage that might be caused by nanoapplications. The representative of the Swiss economy held the view that:

We have legal regulations that impede that something unforeseen will happen. (*Economiesuisse*)

His trust in the existing legislation embraced the political system in general:

We already do have good regulations for products that are already on the market. And we have a system of direct democracy. These are important values. (*Economiesuisse*)

This participant was convinced that the political system is capable and strong enough to prevent any harmful effects that the emerging technologies might cause in the future. His trust in the capabilities of political institutions to deal with new technologies provides the grounds on which he approves the new technologies. This trust in political institutions goes hand in hand with the importance of trust in scientific institutions that Brian Wynne has identified as a key issue for social responses to scientific knowledge [16].⁷

All three narratives are part of general schemes of perception and interpretation of the participants. Since scientific knowledge on nano-risks is still scarce and controversial, the participants drew on other, more common narratives to assess the technologies and support their argumentation.

What to Do? Ta(l)king Measures

A fourth narrative emerged when the discussion focused on actions that should be taken. Most participants' arguments drew on past experiences – mostly regarding their experiences with biotechnologies. Although nanoparticles show more in common with toxins and asbestos, biotechnologies were more salient in the collective memory of the *publifocus* participants.⁸ This was the case regarding both the assessment of the public acceptance and the discussion of regulatory measurements regarding nanotechnologies. Most actors had experienced the public resistance to biotechnology as a difficult political experience, and were keen to avoid the reappearance of such a contested political situation.⁹ For Swiss farmers the political consequences of the public resistance to biotechnology have an impact on their

current agricultural practice. In the fall of 2005 the Swiss population decided on a moratorium that prohibits the release of genetically modified plants for a 5-year period. This moratorium caused major controversy that is still present in the memory and perceptions of many stakeholders. A colleague of the representative of the Swiss farmers quoted above perceived the public awareness and attitudes toward biotechnology as a burden for agriculture:

The agricultural sector cannot afford that the same public hysteria will happen as it did regarding biotechnology. (*Swiss Farmers' Union*)

The consumers' delegate did qualify the attitudes of the public regarding biotechnology as similarly problematic:

We have to collect and widely distribute information objectively and independently, in order to prevent the emergence of a similar panic as was the case with biotechnology. (*kf*)

This participant is convinced that 'objectively' gathering and distributing information will prevent the emergence of a newly contested situation. This view relies on the 'deficit model' in the public understanding of science [2, 9] for its assumption that the public's skepticism toward science is due to a lack of scientific literacy among laypeople. It is a model that has been criticized by STS analysis and empirical studies [e.g., 2, 10, 14, 40–42] but that is, as Wynne proposes, currently being reinvented [43].

The case of biotechnology and the experiences regarding the public controversy were even more present in the argumentations regarding future regulation of nanotechnologies. Suggestions and opinions on how the emergent technologies should be dealt with on a political level were thus informed by such experiences, as is demonstrated by the farmers' representative:

From my experience, I know that the discussion will take off only when it comes to regulatory measures.... We do need legal regulations for nano [technologies].... We could draw on the procedure we had with biotechnology.... Perhaps we should install a similar commission as we did when discussing biotechnology. (*Swiss Farmers' Union*)

For this representative it is crucial not to repeat the same mistakes that had happened when dealing with

⁷ On trust as a key factor in science–society relations see also, among others [2, 39].

⁸ Asbestos and particulate matter were mentioned a few times, but not as often as biotechnologies. The other discussion groups, which included laypersons – but are not analyzed in this article – referred to other technologies more often.

⁹ The heated public debates resulted in a vote on the future of genetic research in 1998. The object of the vote was the so-called Genschutzinitiative that suggested inhibiting the genetic modification of animals, inhibiting the patenting of GMO and its release into the environment, and setting up guidelines for further research in genetics. The vote was accompanied by heated debates and resulted in public street demonstrations of scientists, but was finally rejected by a majority of the electors.

public concerns regarding green biotechnology. The public had not been informed of ongoing research, and public attitudes were considered at a very late stage of the research and development. The farmers' delegate stated:

I strongly disapprove of making it as wrong as we did with biotechnology. Regarding biotech, many said as well in the beginnings that our laws were sufficient. But later on, the opinion leaders said that we need a biotech law. I do not want to go through this again. We should learn from our mistakes, and should not waste any time. (*Swiss Farmers' Union*)

In this respect, the farmers' representative agreed with governmental authorities and with TA-Swiss, which had initiated the *publifocus* as an initiative of 'upstream engagement' in the discussion of nanotechnology. The endeavor to avoid the same mistakes in public debates and policies is thus a shared concern of several stakeholders involved in nanotechnologies. The farmer, however, referred not only to an upstream dialogue, but also to regulatory measurements that in his view should be taken at an early stage of R&D. Regarding such concrete measures, the opinions among the present stakeholders were antagonistic, and different regulatory regimes were suggested.

Regulating Nano: Precautionary Actions, Declaration, or Relying on Existing Laws

In her recent comparative study, Sheila Jasanoff pointed to different regulatory regimes regarding biotechnology in a number of Western democracies [8, 44]. While in the United States biotechnology was regulated with a science-based and product-oriented approach, the UK relied on scientific advisers and what Jasanoff calls a process-oriented approach to regulate biotechnologies. In Germany, in contrast, regulation was shaped by specific science-society relations and was program oriented. Such different regimes on how to deal with emerging technologies were also suggested in the argumentation of the participants of the *publifocus*. Here, three major positions could be distinguished.

The first group of discussants (implicitly) pleaded for a *precautionary principle*. Given the uncertainty of scientific knowledge on nano-risks, it would be better, they claimed, to be cautious, await further industrial developments, and to foster research on

nano-risks to be able to make decisions on the basis of improved evidence. The delegate of the consumers' forum took this point of view:

If there is any danger, you have to wait [with the further development of nano products]. Otherwise you get into a panic situation. That would be an own goal for the industry (i.e., it would be an industry mistake). If we wait, we will not be out of the game. (*kf*)

The trade unions' delegate agreed that regulatory measures should be taken and research money should be deployed to investigate potential risks.

A second group of discussants argued for better *information* for the public, and for a *duty of declaration* of nanotechnology products.¹⁰ "The consumer has to be informed," a consumers' representative (ACSI) held, and his colleague (from the SKS) said that "a duty of declaration could also be a chance for industry." It was not just the consumers' organizations that pleaded for a declaration but, for example, the representative of the Swiss food industry also underlined that "the duty of declaration is very important." The farmers' representative characterized himself as a "great advocate of information and communication" regarding nanotechnology, a view that was shared by many participants.

Finally, a third group considered the existing laws as sufficient and supported what Jasanoff has called a *product-oriented approach* to the regulation of technologies [8, 44]. These participants claimed that the product regulations already in force would include any nanotechnology products available on the market, which would make it unnecessary to take any further actions at the moment. This point of view was taken by the delegate of the Swiss economy (*Economiesuisse*), who said that "we are not on a green meadow" when pointing to the existing laws regarding food, medicine, and other products that required stringent testing before allowing a product enter the market. He strongly pleaded for the liberty of research, which would "take place internationally" and could "not be stopped." The representative of the textile industry supported a

¹⁰ In the laypersons' discussion groups not analyzed in this article, the claim for a duty of declaration was made by most participants.

product-oriented approach that assigns accountability to the producer:

Each producer has to take responsibility and has to face potential accusations. Each one has to know himself if he better keeps away from producing [nano products]. (*Swiss Textile Federation*)

This vision of personal responsibility and of the efficiency of product regulation was mostly shared by the representatives of the economy. However, one of the consumers' representatives agreed that because of strict public and products liability (which required the testing of products) on the one hand, and due to a lack of scientific knowledge on the other, "for the moment, no further efforts are necessary" (*kf*).

In spite of the different positions taken when debating potential regulatory measures, the antagonistic points of view of the participants did not reveal any hardened front lines. More often, the participants drew on their experiences with the political dimension of biotechnology in order to make up their arguments. This interpretative and narrative strategy served as a way to cope with the epistemic uncertainty regarding the potential risks of nanotechnologies.

Conclusion

This analysis of one focus group of the Swiss citizen panel on nanotechnology – the one that involved representatives of stakeholder groups – showed that the participants, in the Swiss context, are rather positive and benevolent toward nanotechnologies. This was the case even though they expressed concerns and were ambivalent when potential risks were discussed. In spite of what several recent STS analyses on the public uptake of biotechnology have shown, the stakeholder representatives in the *publifocus* on nanotechnology did not express a general distrust in science – a finding underlined by Brian Wynne who noted that there "is no general, indiscriminate public mistrust or rejection of 'science'" but "lots of enthusiasm for it" [43, p.212]. Hence, participants in the *publifocus* asked for more scientific knowledge and evidence to be able to decide on regulatory actions. They supported the view that nanotechnologies should be better defined and that a better understanding of the potential risks would be achieved by fostering further research. Also, many

participants shared the opinion that the public should be better informed, thus implicitly supporting the 'deficit model' of the public understanding of science. Besides these rather consensual opinions, heterogeneous attitudes also emerged, especially when debating regulatory measures. Suggestions pointed to diverse concepts such as the precautionary principle or a duty of declaration, or to product regulation. However, different attitudes were not clearly or exclusively expressed between different interest groups, but were also expressed between individual participants belonging to the same stakeholder group. No consolidated conflict lines between the represented organizations could be identified.

In their narratives, the participants drew on their general schemes of perception and interpretation and their experiences on which to base their arguments. General views of humankind and historical progress, individual life attitudes, participants' trust in the political system, and their experiences regarding other technologies formed the epistemic grounds on which the participants built their accounts. This analysis of the *publifocus*' stakeholder group has thus shown that in a situation characterized by epistemic uncertainty, participants tend to draw on their general and habitualized interpretative schemes and experiences to assess emerging technologies.

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