Making Nano Matter: an inquiry into the discourses of governable science

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Accepted to *Science, Technology & Human Values*

Proofs will be sent in November 2011

Abstract

The paper examines science-policy conversations mediated by social science in attempts to govern, or set up terms for, scientific research. The production of social science research accounts about science faces challenges in the domains of emerging technosciences, such as nano. Constructing notions of success and failure, participants in science actively engage in the interpretation of policy notions, such as the societal relevance of their research. Industrial engagement is one of the prominent themes both in policy renditions of governable science, and in the participants' attempts to achieve societally relevant research, often oriented into the future. How do we, as researchers, go about collecting, recording, and analysing such future stories? I examine a series of recent interviews conducted in a number of US universities, and in particular at a university campus on the West Coast of the US. The research engages participants through interviews, which can be understood as occasions for testing the interpretive flexibility of nano as 'good' scientific practice and of what counts as societal relevance, under what circumstances and in view of what kind of audiences.

Keywords: nanotechnologies, society, policy, university-industry relations, governance, innovation.

Introduction: the emerging notions of relevance

The rise of nanotechnologies is accompanied by expectations of their societal benefits. Participants in academia, policy and industry construct nano as relevant to society owing to the institutionalised production, commercialisation and governance of research. An achievement of the National Nanotechnology Initiative (NNI) in the United States was to link 'basic science' in nano and 'societal benefits'.[i] Following the conventions of the US policy discourse that frames university science as a source of industrial innovation, American nano discourses feature various versions of what counts as science for societal benefits. A number of measures and practices have also developed to ensure relevance, such as assessments of impact of research in the context of the broader economy; practices of safety and regulation aimed at environmental responsibility; and integration of social science (ELSI, ELSA[ii], etc.) in governance of emerging research areas.

While societal relevance is seemingly a key feature of the discourses of nano, the foundational visions and early statements of the NNI were very general regarding exactly what *kind* of society will benefit from the anticipated rapid advances in nano. While nano is construed in the foundational documents in terms of national competitiveness, the 'society' to which nano is foreseen as relevant is imagined to be rather homogeneous. President Bill Clinton's (2000) speech at Caltech famously endorsed the NNI - estimated then as $500 million for fiscal year 2001 - for 'the Americans.' The name of the initiative itself, proposed by Mihail Roco, the main architect of the NNI, meant to connote relevance for society: 'The name NNI was proposed on March, 11, 1999, but it was under

"further consideration" until the Presidential announcement because of concerns from several professional societies and committees that the title does not include explicitly "science" (Roco, 2007: 11). We explained that *we selected a simple name showing the relevance to society*' (emphasis added) (Roco, 2007: 13).

As Gallo shows, researchers quickly employed the language of societal benefits in grant proposals aligning with the National Science Foundation's (the main supporter of the NNI) rhetoric of basic science as the foundation for societal benefits: "The NNI exhibits both an adherence to the discursive strategy of linking federal investment in upstream basic research to positive downstream outcomes, as well as a propensity to engage in frontier rhetoric to explain how research conducted at the nanoscale will 'lead to a revolution in technology and industry'" (Gallo, 2009: 208). But cautious voices - emphasising nano as a "difficult" and "speculative" exercise - could also be heard (Kalil, 2001: 22). Notions of the relevant society began to differentiate as deliberations about societal implications developed. Some white papers appearing in 2006-2007 used the language of evaluation of the NNI, which was prompted, according to Roco, by the need to deal with "three waves of scepticism" concerning "the relevance of nanotechnology" (Roco, 2007: 9). These included concerns about, first, the limited relevance of the field and its "pseudoscientific claims"; second, the so-called "grey goo" scenario;[iii] and third, environmental, health and safety hazards, which, according to Roco "arrived only later in 2002-2003 when industrial participation had increased." The framings of societal relevance of nano thus introduced nano as a potential problem rather than an unquestionable solution.[iv]

The third concern in particular grew into a louder debate in 2006, with the US House Committee on Science raising questions about "the lack of guidelines and regulations needed to insure the environmental, health and safety (EHS) of products resulting from nanotechnology".[v] This lack was seen as detrimental for the potential of nano to reach "the industry" and "the consumer" which had been presented as the main beneficiaries for the nanotechnology products. The relevant society is construed in the context of questioning societal benefits of nano as American *consumer* society. The marketisation of nano offers for interpretation a different "mode of accountability" (Dilley, 1992); this discursive move mobilises the voice of the consumer as opposed to channelling the benefits of nano to the military, for example. It also allows for interpretations of nano in public discourse as a commercialisable technology (see Thurs, 2007a).

This paper will further problematise relevance to society as an important element in the discourses of what I term *governable science*, whereby participants negotiate notions of responsibility, good practices and outcomes in a variety of ways. Societal relevance of fields like nano can be seen as a part of the broader promissory and highly visionary discourses of emerging technoscientific initiatives. The notions of societal relevance have bearing on societal acceptability of particular emerging fields, including funding. While histories show deliberation and contention around societal outcomes of nano that are understood as a singular and focussed technoscientific pursuit, a concern that underpins my analysis - conducted in an ethnographic mode - is about the co-production (Jasanoff, 2004) of the specific content of emerging fields and their societal relevance. Scholarly

and research policy analyses often assume the independent existence of emerging fields, such as nano, that have particular and describable evolutionary trajectories of societal acceptance or rejection.[vi] From this point of view, analytic work is largely about accumulating and sorting statements (forward-looking, critique, descriptions) that tell us something allegedly related to the 'field' in question. Such scholarship de-politicises the scientific enterprise, assuming the ambivalences are situated in its context (like public responses; or polarity of societal implications) rather than in nano as the object that public responses are construed in relation to. I will argue that the societal and political organisation of research fields is part and parcel of the deliberations concerning societal relevance of emerging technologies, posing challenges for social science research.

Speaking to broader issues concerning translations and interpretations of science policy discourse (Jasanoff, 2005; Guston and Keniston, 1994), the paper also relates to a wider debate in the sociology of expectations around emerging technologies (Van Lente and Rip, 1998a, 1998b; Brown *et al.* 2000; Sarewitz *et al.*, 2000; Fortun, 2001; Brown and Michael, 2003; Hedgecoe and Martin, 2003; Kitzinger and Williams, 2005; Rabinow and Dan-Cohen, 2005; Sunder Rajan, 2006; Hilgartner, 2007; Selin, 2007; Martin *et al*., 2008; Simakova, 2010). I explore how such discourses contribute to shaping the futures of socio-technical relations through accomplishing moves between the categories of 'basic science' and 'industrial relevance' (cf. Calvert, 2001; Gieryn, 1999).[vii] As a contribution to the literature, I pay special attention to the achieved character of the emerging fields in conversations. The study is based on 25 interviews with scientists and university administrators conducted at several universities in the United States in 2007-

2009, as part of an ethnographic research project aiming to examine the brokering of university-industry collaborations around emerging nanotechnologies. The study included a series of interactions with university scientists and administrators (including knowledge and technology transfer officers) in a number of US universities, as well as policy makers. I also participated in a number of policy and scientific events on university campuses or hosted by funding organisations. Exploring the potential of ethnography to the topic of university-industry interactions, including access to and analysis of accounts and materials I collected, a discourse analytic approach (e.g. Potter and Wetherell, 1987) emerged as particularly well suited to developing a research perspective on the discursive organisation of emerging fields. Such an approach, for instance, would treat participants' accounts, as well as the interactive occasions in which such accounts are produced, as a topic rather than a resource.[viii] As such, while the discursive analytic take helps to identify the discursive elements of the scientific organisational talk – such as metaphors or irony – and understand their functionings, the ethnographic stance assumes that these discursive elements cannot be seen simply as discursive tools, rather their deployment is part of an embodied engagement between researcher and researched, as I will discuss below.[ix]

Introducing irony: discursive displacements

As Selin (2008: 1886) observes, "one problem is that even though the future is always active in even the most mundane of decisions, expectations, and stories about the future

are not always immediately obvious or easy to discern." A concern is looming large: how do we, as researchers, go about collecting, recording, and analysing such future stories? Researching promissory discourses and practices is precisely about identifying and following occasions when stories about the future are told, such as ethnographic engagements, or, more narrowly, interviews. Of the stories about the future I studied, a particular kind concerned achieving societal relevance of nano through university-industry interactions. How was industrially relevant scientific research presented in the situated interactional occasions, such as interviews and informal conversations?

In this paper I suggest a particular inroad into the discourses of societal relevance through the notion of *irony*. Weinstein (1982) drew attention to irony as an element of both sociological analysis and technology assessment: "the long-standing interest of social scientists in the ironies associated with technology articulates closely with the aims and needs of currently prominent policy-oriented fields such as technology assessment and social impact analysis." (p. 293) In the context of promissory fields, irony occurs when the focus is on unintended consequences of practical action, or unintended outcomes of technological development standing "in flat contradiction to what was planned" (ibid.: 296). From a discourse analytical perspective (Potter and Wetherell, 1987: 42), irony is a form of interpretation shared by participants and analyst. While in the participants' discourse irony can be recognised as part of achieving variability of accounts, for the analyst, making note of such irony can help critically evaluate what otherwise may become a favoured analytic story. In this vein, irony – offering a meaning different or opposite to the intended one – is a form of reading opposite to reification, to avoid

treating abstractions as material things, or treat words referring to objects as "guarantees of the actual existence of these objects or processes" (ibid.).

Ironies can thus challenge the researcher's assumptions about participants' practices and beliefs, and help avoid ethnographic work becoming an element in the "bureaucratic reflexivity" (Strathern, 2000b) that often reproduces local understandings of practices. Instead, a research trajectory can include unintended consequences and insights, urging the ethnographer to "make room for the unpredictable" (ibid.). Such an ethnographic approach resists the idea to offer a rendition of the field that reproduces the (science policy) terms of good governance and societal relevance as being an achievable element of scientific and policy work. For instance, it attends to the issues of ethnographic access, which is contingent on the research trajectories, participants' availability, or willingness to disclose information about their work, as a matter of particular analytic concern. As such, the possibility to offer for interpretation participants' ways of going about societal relevance of their work needs to be seen as a partial view that is conveyed in the form of an ethnographic account. Such account, as I intend to show, has to cope with multiple local ways of talking both nano and its societal relevance.

One form of irony that utilises alternative versions of societally relevant science can be called *discursive displacements*. The revelation entails presenting the researcher with alternative descriptions of, for instance, scientific entrepreneurial culture, as she is moving between different locations and scientific tribes. My respondents on the East Coast of the US often pointed at the West Coast as an example of a different kind of

scientific entrepreneurial culture (more active, open, encouraging the entrepreneurial spirit in universities).[x] In order to explore these references to a distinctive culture of the "West Coast," I arranged a series of interviews with scientists, university officials, and technology transfer offices in at least one campus, and completed 20 recorded (and a few unrecorded) conversations through a snowball sampling.

Engagements with industry, and developing entrepreneurial culture, were high on the campus agenda. The official position sounded normative and endorsed interactions with industries as a part of "good engineering research". There was no business school on campus, but various management programs were associated with engineering schools and departments to deliver management knowledge to scientists through establishing close connections with business practitioners. Many participants acknowledged that university members did not experience any pressure to engage in collaborative work. The (many and successful) projects that took off (including start ups) were products of individual scientific entrepreneurial effort. Having an efficient and responsive technology transfer office, a number of industrial liaison officers, and a management educational program for engineers was presented as a value and a measure of success in itself, as available means to "remove barriers" that occur at the early stages of collaborative interactions. For both the technology transfer officers and for the management training programme leaders, educating faculty and students about the requirements of the business world and setting responsible scientific conduct was a primary concern that also stimulated a continuous re-evaluation of their own efforts. Neither for the technology transfer officers, nor for the educational program leaders did nano present a special or a pressing case.

Most participants described the campus as being tremendously successful in terms of attracting federal, army and private financial support and achieving spectacular academic results. Through an earlier fundraising effort, funding bodies and private donors generously supported the construction of infrastructure for interdisciplinary research to contribute to future societal benefits achieved via translating research on the nano scale into the "health and economy of the State." Participants discussed the responsibilities for making research relevant to society as highly fluid if not "pretty chaotic." They often portrayed funding bodies, universities and industries as being in the learning mode. To the extent that, as one of the participants put it, the very formulation of my research as an inquiry into "organisation" of university-industry interactions and forms of audit presupposed "a degree of organisation that many of us would dream we have."

Maintaining the status of a successful institution required dealing with uncertainties, searching for workable collaboration and governance models and implementing those locally. Participants largely agreed that the organizational structures both within and outside the university were never stable. Program managers occupy their posts with funding bodies for only limited terms and allegedly for too little time to be optimally effective. The faculty on campus are enmeshed in a complex web of policies of intellectual property rights and ethics (conflict of interest) committees, the terms of which change from year to year. Articulating which entities were involved in regulatory work - funding agencies, government, industrial partners - entailed judgements upon the capacity or desirability of those entities to participate in the governance of nanotechnologies. The

folk sociologists[xi] in the university evaluated government agencies' abilities to make funding choices. The multi-agency "structure" of the NNI caused considerable distress to some: no single agency among those involved was best positioned to be in charge of translating academic research into products. If an agency were to be made centrally responsible, which one would it be? Who is going to inform that particular agency, and how? Who is collecting information? Some maintained that a network of national labs directors is more capable of producing much better policies than government offices. Would it not be better to reverse the terms of presentation of societal benefits as an outcome of nano: first nominate pressing societal concerns (like water quality) and then see which technologies can provide better solutions for them? The changeable nature of agenda setting was acknowledged, such as the transformation of the imagined beneficiaries of research (e.g. from civil to military communities and back) with the change of the political climate, as evidenced by the inconsistent application of 'Defense' in (D)ARPA.[xii]

Construing the university campus as a "durable locale" (Law 1986) attracting both exceptional scientists and a high rate of investment, the interviewees also nominated other places (universities, disciplines) as locales where good research and governance practices could be observed. Prompted by a discursive displacement of scientific entrepreneurial practices from the East Coast to the West Coast, I noted and interrogated further displacements as a prominent theme in the interviews. A senior university official reflected on some imperfections in a technology transfer training program, and pointed in the direction of some East Coast universities that had implemented successful programs,

while this campus was "just learning." A technology management program leader was excited about a recent article in the *Financial Times* praising technology transfer in an Oxbridge university as an example of best practice. And finally, a leading scientist referred me back to the place I came from for more information about nano infrastructures.

Many participants justified the displacements of best practices as a means to cope with uncertainties that the university, and individual researchers, had to deal with. Establishing oneself as a good player in the world of research universities, or more narrowly nano, entailed linking one's successful identity to a particular location/campus, while letting other features loose. The participants who assumed imperfections in the practices discussed referred not to any kind of university, but to prominent universities in the Boston area, the Ivy League, the University of California, or Oxbridge. Thinking of these places—where presumably good and relevant research is conducted and from which some good practices could be borrowed—as relevant points of comparison positions the campus studied among highly successful institutions.

Thinking and strategising on campus involved identifying the criteria applied by agencies for success in scientific research. Some participants said they scrutinised the agencies' public statements and annual reports to identify patterns and trends in the budget allocations. The common recognition was that *success stories* were the tokens of conversational exchange with funding agencies providing evidence of successful research. Participants, however, did not perceive success stories as the best basis for good

governance, passing poignant remarks about funding bodies wanting to take credit for successful applications without necessarily having a clear vision of what those are. As some observed, in a good system - based on "good judgement" rather than on models - failure counts equally with success.[xiii] But overall, the possibility of telling a story of success largely legitimised the choice of industrial consortia, or individual scientists, who I was referred to. The campus participants had "story stocks" (Fortun, 2001) to share when outlining a pool of campus initiatives relevant to nano, and hence suitable for my purpose. Such stories functioned as legitimate, reified instantiations of success (Selin, 2008) demonstrating the "do-able" (Epstein, 2008) nature of achieving successful university-industry interactions around nano.

Making nano matter

The above begins to suggest that the discourses of nano (and other emerging technoscientific initiatives) need to be seen as skilfully employing a range of devices that help to sustain distinctive boundaries of successful nano research. From a discourse analysis perspective, participants' discourse needs to be treated as a topic, and not as definitive analytical version of action or belief (Mulkay *et al.*, 1983: 199). Suspending assumptions about content of research (cf. also Selin, 2007), it is important to understand how participants themselves make sense of nano while discussing its societal relevance. In other words, the analysis needs to attend to how normal science acquires its identity as

nano through participants' effort to *make nano matter*, in the sense of constructing both the substance of their science as nano, and the societal relevance of their work.

Locating practices related to nano on the particular campus prompted questions about the boundaries of nano. Certain kinds of research, like spintronics, were identified as belonging to nano with a high degree of certainty, which was reinforced by its location in a building dedicated to research on the nano scale.[xiv] However, the research presented to me as successful collaborations with industry around nano also included further discursive displacements towards material science, toxicology, chemistry, engineering, theoretical physics and arts. That also meant meeting participants in their departments that were not located in the nano building. Presenting their research as nano, participants employed, in a scientist's apt term, 'reasonable definitions' of nano research adopted for their purposes at hand. Such definitions included historicising nano and connecting current research to earlier disciplinary traditions, e.g. material science, polymers science or overall a variety of research on the nano scale that took place over the past few decades. The historical displacements bring in claims for a solid disciplinary background and leverage on commercialisation with companies not preoccupied with the nano label. For nanotoxicologists, it was important to nominate both materials that would count as nanoparticles ('clay'), processes ('coatings') and industries ('pharma') that could be made liable for the use of such materials, also being aware of companies using the nano label in highly selective ways. The number of substances that they could categorise as nanoparticles for testing depended, however, on the duration and amount of their funding. For those attempting to present nano through the language of interdisciplinarity, a Venn

diagram helped to hold the disciplines (such as nano and bio) together in their conversations with the sponsor interested in biomedical applications on the nano scale.

In this regard, university talk is less of a response to a single consensus-based policy challenge conceived of as one in a set of 'analogous' research programs (e.g. such as genomics). Rather, participants employ such analogies in practice to make sense of nano in science, policy and science administration to resolve situated governance controversies.[xv] One occasion when ambiguities about nano research come to the fore is in grantee forums bringing together representatives of universities, policy and industries, organised by funding bodies.[xvi] Such meetings exhibit a high degree of uncertainty about what counts as promising trends in nano; while for scientists it is important to present their work as recognising and addressing emerging concerns, funding bodies managing nano budgets also need to offer an account of the state of the arts in the area. For both grantees and funders, this is an unstable situation. Funding bodies find themselves under scrutiny by numerous other agencies as part of accountability mechanisms within the multi-agency structure of the NNI, or due to interest from other agencies exploring opportunities in nano. Changes in the course of action may occur due to the need to accommodate comments from some external assessors. Next year's funding priorities announced in such meetings may swing, for example, from research exhibiting relevance to industry to one that develops the theoretical foundations of nano. In turn, chemists, physicists, and biologists may disagree about such theoretical basis for nano, advancing theories derived from their own disciplinary cultures (such as a periodic table *versus* principles of quantum mechanics, or classification of biological properties of

nanoparticles). A certain degree of openness from both policy and scientists helps to keep the research enterprise going, as does making room for various framings of societal relevance of such research. As such, nano turns out to be less well-defined substance of research and technologies, and more a flexible strategic resource with currency in science and policy, where the appropriateness of such resource is deliberated.

Situating societal relevance

Potter and Wetherell (1987) talk about ironization, or a process where descriptive language is treated not as genuinely descriptive but as having another purpose or a deception, which introduces a possibility to treat discourse as *strategic* ironies in (governance) situations that participants describe as uncertain. The narratives of societal relevance also serve as examples of what Myers (1996: 3) called "strategic vagueness" in academic writing, enabling "terms and interests of one group to be translated into ones of another group". Vagueness features also in the participants' talk as they are "tapping into an untrodden territory", where it's "all vague", and where roads "are very hard to negotiate." As such, the strategising is construed as being largely about strategic choices in accounting for both content of research and its societal relevance that would receive favourable interpretations and connect to policy communities.

Narratives of societal relevance were interleaved with deliberations about acceptable ways of talking nano that involved specifying circumstances of assessment and audiences

for research.[xvii] In other words, the conversations can be seen as instantiations of performances of 'accountability', as in (Strathern, 2000a: 2) hinging on local, situated, and contingent appropriations of notions of society. In grant proposals, for example, the groups, or audiences between which claims for 'societal' relevance are translated, are extended towards, and specified as, communities of funders, members of industry, and society at large exemplified in situated accounts. Such accounts also serve as examples of the discursive production of nano in terms of substance and the politics of the areas of scientific research.

Policy and funding bodies as general entities featured prominently as the principal assessors of scientific work, whereby the appropriate ways (framed to an extent by interview purpose itself) were recognised as presenting nano research carrying an industrial promise. However, some participants advanced more contentious renditions of nano, such as the perception of it as 'pseudoscience', or articulating sarcastic commentaries about whether nano is a new or distinctive scientific breakthrough. The cynicism was associated with a discursive move portraying nano as not being the substance of scientific and technological artefacts, but as a term (even an "unscientific", term) detached from the "real" practice and used as a currently fashionable label to attract funding. Other quotes portrayed nano as the repackaging of existing scientific disciplines now lacking funding or wanting more of it; as "marketing"; as an oversimplification that funding bodies like to hear.

Commentaries could be heard about the funding bodies' taking for granted assertions about the 'qualitatively different' properties of nano. Some scientists noted policy's reliance on the language of 'paradigms.' They suggested that paradigms were not a given status of a scientific field, but rather used purposefully. As such, participants engage in persuading each other, and their funders, in the new paradigmatic status of their science, and also demonstrating its societal relevance. Some conversational fragments were apt instantiations of the discursive co-production of the content and relevance of scientific work. For instance, a nanobiotech centre entertained the military-oriented notions of relevance, with the soldier being the ultimate beneficiary of their research. My question about differences and similarities between nano and bio resulted in a moment where my respondent and I both struggled with ironicising nano as being both a substance of research which had certain differences and commonalities with bio, and a label to put on the research in conversations with stakeholders (the Army in that case):

> I: Do you operate within the same, you think you operate within the same or different, ah, sets of, um, conditions?
>
> R: Um, well [pause] hmm. I haven't actually done a nanotech sale, so … [laughs].
>
> I: You don't have to sell it to me! [laughs]
>
> R: Right, right, right. I'm not quite sure how to answer your question, honestly [laughs].

Some comments providing views of science as a free-standing pursuit accomplished a form of cultural defence against government steering and accountability measures (see also Calvert, 2001). The examples include a scientist's "resistance" to policy instigating societal demands for scrutiny of science "where everything is free and ad hoc." Social science research, understood by the participant as an attempt to present scientific research for societal judgement, was rendered an unwelcome "fashion". Another administrator bluntly denied the capacity of funding bodies to produce good judgement about the nature of the university research. The responses performed a version of ethical scientific behaviour quite different from one promoted by the ELSI initiatives to access and describe scientific practices in terms of their societal "impact" that some participants perceive as one such government accountability measure. A multimedia facility presented the scientific community as the primary assessor of their effort. Reaching out to industries, although being a part of strategic presentation, was rendered a difficult and a far off concern. Anticipating possible criticism that such inclusiveness may be perceived as lack of selectivity and relevance, the leader nominated his centre's work to the be among the best:

> There's method in our madness, we picked the scientists that are … working with some of the most gorgeous complex data that lets us make the most beautiful abstract art that you'd ever want to put your hands on.

Another research consortium was entangled in a double accountability structure in the university and with the corporation-sponsor. The quotes below illustrate selectivity in accounting for research and industry relations in terms of nano, and perform assumptions about (in)appropriate occasions of politicising (labelling, assessing and evaluating) scientific research. According to the dean, "doing" (science) or "talking" (politics) nano are occasions when such labelling takes place:

> It's just that we don't sit around and talk about it.

> We don't talk about nano very much we just do it when it's necessary.

The circumstances "when it's necessary" to produce an account, or an accountable action, that could count as nano (research, or talk) are presented as an open interpretive matter. In clarifying what these circumstances of accounting might be in the double accountability structure as above, the corporation was construed as being ultimately responsible for commercialisation.

In another interview, sustaining "good" nano research was portrayed as depending on *not* applying any assessments too hastily. The deferral (Rappert, 2005) of the realisation of the promise of nano thus cautioned against 'false' expectations about good research. The relationship between societal accountability and good academic research was articulated as a cautionary tale about previous negative effects of 'societal impatience' on other technological initiatives as a result of the 'incompatibility' of industrial and funding

agencies' schedules. The cautionary tale of assessment thus appears an element of a success story of nano research that does its job well, but is being threatened by a potential disruption provoked by poorly informed expectations.

In what can be recognised as ironic ways, the participants were able to render alternative descriptions of nano as opposed to policy discourse. Such ironies notably perform the relationship between *substance* and *politics* of scientific research. The participants employ irony as a means to offer an alternative to the received view of nano that relies on the metaphors of scientific rationality: "you think nano is this (a new paradigm; new properties of matter investigated at the nano scale), but we know that it is something else (it is "merely" a label)." As such, depending on the circumstances of accounting, 'nano' as a prefix may point to both technical content of research, as well as to a social and institutional organisation sustaining nano in focus. As a policy category, for instance, the nano prefix would perform a community of grantees, so a 'nano grantee' meeting would not be recognised as a gathering of very small people, but of scientists receiving, or aspiring for, funding under a particular category. The distinction between the technical meanings of nano and its social organisation subtly does the work of configuring and reconfiguring the field rather than 'simply' denoting certain science done on the nano scale, or its technological implications.

But how can particular statements or situations be understood as ironies? Although the 'structural features' of such ironies (Mulkay *et al*., 1988: 200) can be identified as above, they need to be understood and interpreted as such by the analyst, who also needs to

convince her or his readers that a particular statement is ironic. Admitting that irony can be experienced as great surprise, or even shock, Weinstein asks: "who is it that senses the shock of irony: the social scientist, some actors, all actors, social scientists and actors alike?" (1982: 296) As such, irony entails certain – methodological and practical – consequences. Discussing the constructivist position and its use of ironies as the analytical unpacking of, for example, scientific facts in terms of their social organisation, Woolgar (1983: 240) observes that "ironies done with respect to science have a special poignancy; it is these ironies which enable the constructivist sociologist to advance knowledge claims about knowledge claims." As such, describing something as irony may even be considered "victimising" the participants' talk, because of the participants' lack of the "foreknowledge of the sociologist and his audience" (259), while the researcher would have 'access to irony' in the sociological community.

Equally, a social scientist may lack access to irony in the community of scientists. A situation bringing together a social science researcher and scientists in a conversation is a test for the "interpretative competence" (Mulkay et al., 1988: 200) for both: while the researcher is trying to make sense of the laughter occurring in conversation, participants might wonder, sometimes explicitly, about the significance, consequences, or need for presenting their alternative views of science. While anonymity was a part of participant recruitment, some respondents passing such commentaries would insist on being mentioned, even continuing discussion by email, perhaps seeing the social scientist as a potential translator of the campus talk to policy – presenting my project as being funded by NSF was an important part of the introductions. Others, on the contrary, highlighted that parts of our conversations were off record, which I took as my duty.

Judging the appropriateness of certain remarks, the multiple interpretive competences were evidenced explicitly for participants to recognise the researcher as 'one of us', through discussing my background in physics with scientists; a business programme faculty passing a remark of a possibility for me to be offered a job as a social scientist on campus; or a question that perhaps I had background or experience in licensing myself when talking to the legal officers. It became obvious that as a social scientist who is trying to get to grips with the discursive organisation of the emerging fields, I would have to deal with certain unpopular views. Publishing such findings as a reproduction of the 'reality' of the campus atmosphere can be seen as a welcome or unwelcome political move, contributing, for instance, to the dismissal of the scientific, and political, status of an emerging initiative, especially if such views become attributed to particular individuals. Hence, anonymising particular settings and interlocutors has become a necessary means to minimise the "shock" of disclosing views going against the established ways of talking nano (as a sound science; as being open to societal scrutiny). But is this not what everybody knows already?

Conclusions: construing governable science

The paper discussed issues at stake in the conversations between science and policy mediated by a social science researcher. Such conversations concern what I termed governable science, or as accounts distributing responsibilities, good practices and

outcomes in a variety of ways. I have considered a particular research episode: interviews conducted on a particular campus constructing itself as a successful player in nano, examining how participants flexibly interpreted university-industry interactions around nano as a part of governable science. Such flexibility was achieved in three main ways.

First, the variability in the application of notions of success was intertwined with the elaboration of the circumstances of assessment and the identities of assessors (e.g. industrial partners; academic peers; social science researchers; the construction of wider societal opinion). Second, the ironic definitions of nano performed a number of discursive shifts, or displacements: towards other places, disciplines, or modes of accountability. I have suggested that the displacements can be recognised as a particular kind of irony that offers alternative descriptions of reality, comparatively relocating the science conducted on a particular campus to these other locales, or within scientific traditions (historically; disciplinary). The third theme that runs through the analysis is the cultural response to the policy terms of societal relevance. The discursive strategies suggested certain closures on the interpretive openness of nano but open other places, disciplines and forms of assessment for interpretation that a researcher may or may not choose to further investigate. In this vein, the interplay of interpretations of nano as science and/or politics ratify irony as *project*[xviii] (Woolgar, 1983: 260) whereby the (strategic) irony in this reading is not bounded by the text, nor fixed as a specific occasion for sociological work, but highlights for the reader the infinite interpretative possibilities of the text.

Presenting their research as normal, ordinary science as opposed to exaggerated claims of revolutionary potential in the policy rhetoric of nano, participants stressed that such normal, ordinary science involves the need to resolve practical matters, to engage in interactions with industries that may or may not go well, and to establish its own position in the scientific domain through selective use of the nano label. Being a proper participant in this kind of scientific 'business as usual' involves the game of getting grants and industrial funding, and, as above, ability to perform the insider/outsider distinction in situations recognised as permitting (or not permitting) participants to openly acknowledge ironies. The uncertainties also open up strategic opportunities as participants engage in testing the interpretive flexibility of nano in the debate about governable science and of what counts as societal relevance.

Further analysing the features of the conversations, I discussed in what sense the participants' talk can be understood as employing strategic ironies. However, such analytic rendition of the participants' discourse would be incomplete, and even analytically naïve, without recognising the role of the researcher in the constitution of scientific talk in terms of irony. Namely, in the interactional occasions whereby accounts of societal relevance are produced, the participants and the researcher develop and share interpretative competences in order to first, recognise the ironies, and, second, evaluate the acceptability of the ironic definitions (of science-policy conversations, of particular research programme). In a similar vein, the purpose of the study itself was interpreted by the participants differently, as well as the role of the researcher. No (ironic) surprise then that some participants perceived the study as an instantiation of societal 'impatience' with

regard to moving closer to the successfully achieved promise of nano, and instead of offering presentations of their research as being societally relevant, chose to engage in a form of critique. As such, instead of studying the science-policy interface in a detached way, research projects such as this become engaged in actively constructing the 'interface' through, for example, offering renditions of policy by scientists. Thus, the dynamics of bringing substance and politics of research together or keeping them apart seem a central part of the speculative, on-going, knowledge production work. The appraisal of the active reinterpretations of policy notions that bring the political and the technical together in various ways within the fields of science can possibly initiate a new kind of apprehension of the construction of governable science mediated by social sciences.

Acknowledgements

This paper is an outcome of a three year research project supported by the Center for Nanoscale Systems in Information Technologies, Cornell University, a NanoScience and Engineering Center of the National Science Foundation under Award # EEC-0117770, 0646547, jointly with the Department of Science & Technology Studies (S&TS) also at Cornell. The study also benefited from a research grant from the Center for Nanotechnology in Society at the University of California at Santa Barbara (CNS-UCSB). My particular thanks go to Stephen Hilgartner, Trevor Pinch, Geoff Bowker, Katie Vann, Daniel Neyland, and two anonymous reviewers of Science, Technology &

Human Values for their many helpful suggestions. I am also grateful to the organisers (Maja Korica, Carmelo Mazza, Paolo Quattrone, and Steve Woolgar) and participants of the sub-theme 16 "Societal accountability: Understanding and negotiating the identity of individuals, societies and institutions" of the 25th European Group for Organizational Studies (EGOS) Colloquium, Barcelona, in July 2009, which inspired the first draft of the paper.

References

Barben, Daniel, Eric Fisher, Cynthia Selin, and David Guston. 2008. Anticipatory Governance in Nanotechnology, in Hackett, E. et al. (eds.). 2008. *The Handbook of Science and Technology Studies, Third Edition*. Cambridge, Massachusetts; London, England: The MIT Press. 979-1000.

Brown, Nik, Brian Rappert and Andrew Webster, eds. 2000. *Contested Futures: a Sociology of Prospective Techno-Science*, Burlington, VT: Ashgate.

Brown, Nik and Mike Michael. 2003. A Sociology of Expectations: Retrospecting Prospects and Prospecting Retrospects, in *Technology Analysis and Strategic Management* 15(1): 3-18.

Calvert, Jane. 2001. Is there a role for 'basic research' in Mode 2?, *VEST Swedish Journal for Science and Technology Studies*, 13 (3-4): 35-51.

Committee on Science and Technology, U.S. House of Representatives, Press Release "Consumers Deserve Plan Ensuring Safety of Nanomaterials", 21 September 2006.

Dilley, Roy. 1992. Contesting Markets: A General Introduction to Market Ideology, Imagery and Discourse, in Roy Dilley (ed.) *Contesting Markets: Analyses of Ideology, Discourse and Practice*: Edinburgh University Press, 1-37.

Epstein, Steven. 2008. The Rise of `Recruitmentology': Clinical Research, Racial Knowledge, and the Politics of Inclusion and Difference, in *Social Studies of Science* 38: 801-832.

Fortun, Mike. 2001. Mediated speculations in the genomic futures markets. *New Genetics and Society* 20 (2): 139-156.

Gallo, Jason. 2009. The Discursive and Operational Foundations of the National Nanotechnology Initiative in the History of the National Science Foundation, in *Perspectives on Science* 17(2): 174-211.

Gieryn, Thomas. 1999. *Cultural Boundaries of Science: Credibility on the Line*, Chicago: Chicago University Press.

Gieryn, Thomas. 2006. City as Truth-Spot: Laboratories and Field-Sites in Urban Studies, in *Social Studies of Science*, Vol. 36, No. 1: 5-38.

Grunwald, Armin. 2005. Nanotechnology: A New Field of Ethical Inquiry?, in *Science and Engineering Ethics* 11 (2): 187-201.

Guston, David and Kenneth Keniston. 1994. *The Fragile Contract: University Science and the Federal Government*, MIT Press.

Hackett, Edward J., Olga Amsterdamska, Michael Lynch and Judy Wajcman, eds. 2008. *The Handbook of Science and Technology Studies*, Third Edition, Cambridge, Massachusets; London, England: The MIT Press.

Hedgecoe, Adam and Paul Martin. 2003. The drugs don't work: expectations and the shaping of pharmacogenetics, in *Social Studies of Science*, 33 (3): 327–364.

Hilgartner, Stephen. 2007. Making the bioeconomy measurable: politics of an emerging anticipatory machinery, in *BioSocieties* 2 (3), 382–386.

Jasanoff, Sheila. (ed.). 2004. *States of knowledge: the co-production of science and social order*. Routledge

Jasanoff, Sheila. 2005. *Design on Nature: Science and Democracy in Europe and the United States*. Princeton and Oxford: Princeton University Press.

Kalil, Thomas. 2001. National Nanotechnology Initiative, White House (Transcript from September 28, 2000), in Mihail Roco and William Bainbridge (eds.) *Societal Implications of Nanoscience and Nanotechnology*. *National Science Foundation*: 20-23. http://www.wtec.org/loyola/nano/NSET.Societal.Implications/ Last visited 27 February 2011.

Kitzinger, Jenny and Clare Williams. 2005. Forecasting science futures: legitimising hope and calming fears in the stem cell debate, in *Social Science and Medicine* 61(3): 731-740.

Law, John 1986. On the Methods of Long Distance Control: Vessels, Navigation and the Portuguese Route to India, in John Law (ed.) *Power, Action and Belief: A New Sociology of Knowledge?* London: Routledge and Kegan Paul: 234–263.

Martin, Paul, Nik Brown and Alison Kraft. 2008. From Bedside to Bench? Communities of Promise, Translational Research and the Making of Blood Stem Cells, in *Science as Culture*, 17(1): 29-41.

Moerman, Michael. 1965. Ethnic Identification in a Complex Civilization: Who Are the Lue?, in *American Anthropologist*, 67: 1215–1230. doi: 10.1525/aa.1965.67.5.02a00070.

Munro, Roland and Jan Mouritsen, eds. 1996. *Accountability: Power, ethos and the technologies of managing*. London: International Thomson Business Press.

Mulkay, Michael, Jonathan Potter, and Steven Yearley. 1983. Why an analysis of scientific discourse is needed. In Karen Knorr and Michael Mulkay (eds.) *Science observed: Perspectives on the social study of science.* London: Sage: 171-203.

Myers, Greg. 1996. Strategic Vagueness in Academic Writing, in Ventola, Eija and Anna Mauranen (eds.) *Academic writing: intercultural and textual issues*. John Benjamins Publishing Company: 3-19.

Potter, Jonathan and Margaret Wetherell. 1987. *Discourse and Social Psychology: beyond attitudes and behaviour.* London: Sage.

President Clinton's Address to Caltech on Science and Technology. 2001. The White House Office of the Press Secretary (Los Angeles, California), for Immediate Release January 21, 2000.

http://pr.caltech.edu/events/presidential_speech/pspeechtxt.html

Last visited 27 February 2011.

Rabinow, Paul and Talia Dan-Cohen. 2005. *A Machine to Make a Future: Biotech Chronicles*. Princeton, NJ: Princeton University Press.

Rappert, Brian. 2005. Prohibitions, Weapons and Controversy: Managing the Problems of Ordering, in *Social Studies of Science* 35: 211-240.

Rip, Arie. 2006a. Folk Theories of Nanotechnologists, in *Science as Culture*, 20 Vol. 15, No. 4: 349–65.

Rip, Arie (2006b) A Co-evolutionary Approach to Reflexive Governance – and Its Ironies, in Jan-Peter Voß, Dierk Bauknecht, René Kemp (eds.), *Reflexive Governance for Sustainable Development*. Edward Elgar: 82-100.

Roco, Mihail. 2007a. The Nanotech Future: A Conversation with Mihail Roco, November 09 2007 in *Woodrow Wilson Center* Events page. Available at: http://www.wilsoncenter.org/index.cfm?topic_id=166192&fuseaction=events.preview&event_id=311769
Last visited 27 February 2011.

Roco, Mihail. 2007b. National Nanotechnology Initiative – Past, Present, Future, in *Handbook on Nanoscience, Engineering and Technology*, 2nd ed., (Taylor and Francis): 3.1-3.26.

Sacks, Harvey. 1992. Lectures on Conversation, Vol. 1, edited by Gail Gefferson. Blackwell.

Sarewitz, Daniel, Roger A Pielke Jr and Radford Byerly Jr, eds. 2000. *Prediction: Science, Decision Making, and the Future of Nature*. Washington, DC: Island.

Selin, Cynthia. 2007. Expectations and the emergence of nanotechnology, in *Science, Technology and Human Values* 32 (2): 196–220.

Selin, Cynthia. 2008. The Sociology of the Future: Tracing Stories of Technology and Time, in *Sociology Compass* 2/6 (2008): 1878–1895.

Shapin, Stephen and Simon Schaffer. 1989. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton University Press.

Simakova, Elena. Forthcoming. Collaboration talk: the folk theories of nano research, in *Science as Culture*.

Simakova, Elena. 2010. RFID "Theatre of the Proof": Product Launch and Technology Demonstration as Corporate Practices, in *Social Studies of Science* 40 (4): 549-576.

Strathern, Marylin 2000a. New Accountabilities: Introduction, in Marylin Strathern (ed.) (2000) *Audit cultures: Anthropological studies in accountability, ethics and the academy*. London: Routledge: 1-18.

Strathern, Marylin. 2000b. Accountability… and ethnography, in Marylin Strathern (ed.) *Audit cultures: Anthropological studies in accountability, ethics and the academy.* London: Routledge: 279-304

Sunder Rajan, Kaushik. 2006. *Biocapital: the Constitution of Postgenomic Life*. Durham, NC: Duke University Press.

Survey on Nanotechnology Governance, Volume B. 2006. The Role of Industry, IRGC Working Group on Nanotechnology (Chair: M.C. Roco, Member IRGC; P.M.: E. Litten), Geneva, April 2006. Available at:
http://www.nsf.gov/crssprgm/nano/reports/wgn06-0401_survey_nanotech_governance.pdf
Last visited on 27 February 2011.

Thurs, Daniel. 2007a. No Longer Academic: Models of Commercialization and the Construction of a Nanotech Industry in *Science as Culture*, 16 (2): 169 – 186.

Thurs, Daniel. 2007b. Tiny Tech, Transcendent Tech: Nanotechnology, Science Fiction, and the Limits of Modern Science Talk, in *Science Communication* 29: 65 – 95.

Van Lente, Harro and Arie Rip. 1998a. Expectations in technological developments: an example of prospective structures to be filled in by agency, in Cornelis Disco and Barend

van der Meulen *(eds.) Getting New Technologies Together: Studies in Making Sociotechnical Order*. New York: Walter de Gruyter: 203-229.

Van Lente, Harro and Arie Rip. 1998b. The rise of membrane technology: from rhetorics to social reality in *Social Studies of Science*, 28 (2): 221-254.

Weinstein, Jay. 1982. Irony and Technology: a qualitative technique for applied social science, in *Social Science Quarterly*, 63 (2): 293-311.

Woolgar, Steve. 1983. Irony in the Social Study of Science, in Mulkay, Michael and Karen Knorr Cetina (eds.), in *Science Observed*. London: Sage: 239-266.

Woolgar, Steve. 1997. Accountability and identity in the age of UABs, *CRICT Discussion Paper 60*, Brunel University, February.

Woolgar, Steve and Catelijne Coopmans. 2006. Virtual Witnessing in a Virtual Age: A Prospectus for Social Studies of E-Science, Chapter 1 in Christine Hine (ed.) *New Infrastructures for Knowledge Production: Understanding E-Science*. Idea Group Inc: 1-25.

Woolgar, Steve, Christopher Coenen, and Elena Simakova. 2008. The Ontological Politics of Convergence, Appendix C of the E*uropean Commission's CONTECS Final*

Report "A possible agenda for the social sciences and humanities in the light of the convergence development", May 2008.

http://www.contecs.fraunhofer.de/

Last accessed 27 February 2011.

[i] As Guston and Keniston (1994) and Jasanoff (2005) observe, notions of societal relevance of science have been interpreted and institutionally implemented differently, in both historical and national contexts. The NNI emerged when the US technoscientific policy making attempted to establish conventions of accountability based on the democratisation of science (Barben et al., 2008).

[ii] The so called Ethical, Legal and Societal Aspects (ELSA) research has been introduced into the discourse of NNI as an important (although contested in e.g. Grunwald, 2005) part of the rhetoric of "nanoethics".

[iii] The 'grey goo' refers to a doomsday scenario coined by Drexler in his book *Engines of Creation* (Doubleday: 1986). The term has become an in and out of fashion part of the mythology of nano in both policy and public domains (Thurs, 2007b). Arguably, the scenario contributed to the labelling of nano as a pseudoscience, and the role of this and other early sci-fi and technofuturistic claims in the contemporary discourses of science remains contentious. Barben *et al.* (2008) mention the exclusion of "molecular nanotechnology" (as in Drexler's work), labelled as science fiction, from the list of legitimately funded disciplines in the US science policy. Scientists at times downplay it as irrelevant to the content of scientific work.

[iv] A survey on nanotechnology governance (IRGC Working Group on Nanotechnology, 2006) stresses the lack of "nationally or internationally agreed standards" or best practices known to industrial representatives who participated in the survey; no mentions of coherent effort in industries to engage in ELSI research mandated in academe; the document also emphasises the diversity of approaches to the risk governance

practices and varying degree of enthusiasm on the industry side to identify and implement precautionary measures such as environmental assessment.

[v] Committee on Science and Technology, press release 21 September 2006.

[vi] The CONTECS (Converging Technologies and their implications for social sciences and humanities) being a notable exception, taking the lack of common definition of convergence as its premise. Final Report "A possible agenda for the social sciences and humanities in the light of the convergence development", May 2008 is available at: http://www.contecs.fraunhofer.de/

[vii] Elsewhere (Simakova, forthcoming) the discursive production of nano is seen as moves between general and specific categories of emerging technologies.

[viii] See also (Simakova, forthcoming) for a more detailed discussion of the discourse analytic approach I adopted in the overall project.

[ix] I am grateful to an anonymous reviewer for raising this point about how discourse analysis and ethnography differ in influencing the way in which irony is deployed and analysed.

[x] This analytic theme is familiar from anthropology. In Moerman's (1965) study of demarcation between ethnic communities participants typically said that the "real" representatives of a tribe could be found somewhere else as they pointed to "other places."

[xi] The term "folk sociologists" is not a negative label, but a reflection of ethnomethodological assumptions about the lack of a principled difference between the ways lay participants and professional sociologists make inferences about the world through accomplishing social structure, ordering and turn-taking (e.g. Sacks, 1992; see also Rip, 2006a).

[xii] Defense Advanced Research Projects Agency

[xiii] In some sense, their structure parallels the motifs of Robert Boyle's attempts at sustaining the "modesty of the experimental narrative" (Shapin and Shaeffer, 1984) in the dissemination of experimental techniques for the creation of knowledge that resists attacks of critics.

[xiv] See also (Gieryn, 2006) discussing the role of buildings in the constitution of scientific fields.

[xv] See (Rip, 2006a), (Hilgartner, 2007) and (Simakova, forthcoming) for discussion of the uses of metaphors in the discourses of governance of emerging technologies.

[xvi] One can ask a similar question about the construction of nano as a rational (in the ethnomethodological sense) category in policy discourse.

[xvii] As Woolgar and Coopmans (2006) observe, in the areas of scientific research employing revolutionary rhetoric, scientists appear to be skilful strategists identifying and managing audiences for research, and acting within multiple, or even "interlocking" accountabilities. The recognition and interpretation of regimes of accountability is part and parcel of practical action and knowledge production in academia, policy and management (Strathern, 2000a; Munro and Mouritsen, 1996; Woolgar, 1997).

[xviii] Or irony-as-practice, as in (Rip, 2006b: 94).