Representation as a matter of agency: a reflection on nanotechnological innovations

José Manuel de Cózar-Escalante
University of La Laguna, Spain

Departamento de Historia y Filosofía de la Ciencia, Campus de Guajara, 38200 La Laguna, Tenerife, Spain jcozar@ull.es

Abstract

One of the problems that surfaces when we try to involve society in the deliberation of science-based policy issues --the main goal of PATH--, is figuring out the best way to represent a diverse and diffuse public in this deliberation. Although this is primarily a matter of political representation, we cannot ignore the epistemological aspect of representation. By investigating the connections between political and epistemological representation, using the field of nanotechnological innovations as a basis, we can better comprehend the problem of representation and improve the channels of public participation in science and technology. In order to carry out this analysis we propose using agency as the central concept because this approach (1) utilizes the fundamental trait that both types of representation have in common: epistemological and political representation can be analysed in terms of "nodes" where different kinds of agency come together and at the same time they are themselves both products of agency that unleash successive chains of actions; (2) it also allows us to understand the mechanism of self-vindication used by representational scientific and technological networks; (3) it minimises the anthropocentric bias in discourse about representation since it acknowledges non-human agency; and (4) it clears the way for the creation of public participation mechanisms in the deliberation of scientific and technological material.

In order to illustrate this we will briefly consider a case of nanotechnological innovation: diagnostic tools for cancer diagnosis and treatment.

1. Introduction: participation and its perils

Over the past few years, the mistrust of traditional methods of political representation has driven Western countries to experiment with a multitude of new deliberative mechanisms aimed at fostering wider representation in the political decision making process. As these experiments have proliferated rapidly, the temptation to naively ignore their problems has become more and more difficult to overcome. Most promoters of greater citizen participation in public policy have long been aware of the weaknesses of these participatory methods and the perils of idealizing them: ineffectiveness, delusion, deception, cooptation and the possibility that they can be used to force the public to accept decisions that have already been taken. It's not enough to simply invoke participative deliberation in order to 'heal' a dysfunctional political situation; in fact, in some cases it can be just another way of concealing unfair power imbalances. Yet, because it is so difficult to fairly represent the entire public, it is reasonable to adopt a strategy that multiplies and diversifies the options rather than excludes them. In other words, while we should be realistic about the drawbacks of traditional and 'participatory' forms of political representation, at the same time we should try to preserve their positive aspects

while complementing them with other kinds of 'networking' such as community-based research, science shops, 'creative appropriation' of scientific findings and innovations, different kinds of activism, etc. In short, we should seek a broader conception of representation for the politics of science and technology, a representation that is better suited to the intricacies of our increasingly technological and globalised world.

The public debate on nanotechnological innovations provides us with a great opportunity to imagine and test more intricate and multifaceted ways of political representation. Like other new and powerful technologies, it will almost certainly have a crucial impact on all spheres of society. While nanotechnology is potentially enabling, it is also disruptive. The range of envisioned applications will affect the entire planet and all of its inhabitants. In this scenario, matters of epistemological representation (knowledge about nano-entities, nano-devices and their effects) will play a pivotal role in creating scientific and political policies on nanotechnological developments. In order to illustrate the imbrications of epistemological and political representations, we will use nanotechnological tools for the medical diagnosis of cancer as an example.[1]

2. Power and agency

In order to ensure fair political representation in matters of nanotechnological innovation the troubling problem of asymmetrical power has to be confronted. But power is a heavily value-laden concept. While it is tempting to directly tackle the asymmetries inherent in how decisions are taken on the development of new nano-technologies between the different groups who have a stake in the process (such as researchers, public and private decision makers and 'the public'), this approach may lead to an overly simplistic vision of the ethical and political complexities that arise when the elements of a nano-network interact. Moreover, strictly speaking there is no such thing as 'nanotechnology', so to be in favour of or against it as a whole makes little sense.[2] What is more significant --and more desirable-- is finding good reasons to support or reject specific nanotechnology projects and trajectories. To accomplish this we need to investigate the powers involved in the dynamics of the technological network (Callon 1995, Hughes 1983). The interplay of these powers is agency, in other words, the ability of people or things to act, to exert power. And representation is first and foremost a matter of agency, of acting and 'enacting' things (Law 2004).

Power, understood as agency, is an ontological and evolutionary reality. If anything, the ability to transform the environment seems to be a 'positive' trait of living beings.[3] From an ethical and policy point of view, the trouble begins when action is monopolized at someone else's expense. Also when an agent imposes a course of action on others; and more subtly, when an agent mediates --not necessarily by coercion– another's agency. For instance, this occurs when particular agents are obligated to perceive and interpret certain situations in the way that a

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[1] For a comprehensive, balanced introduction to nanotechnological innovations see the report by The Royal Society & The Royal Academy of Engineering 2004.

[2] Besides, if nanotechnological innovations multiply, extend and are routinely applied in all the sectors of human activity as expected, the very prefix 'nano' will become more and more redundant and will sooner or later fade away.

[3] In fact, even non-living beings possess a kind of agency as well, as the powerful forces displayed in 'natural disasters' periodically remind us.

more powerful agent dictates; this can be considered a form of unauthorized restriction. Unfortunately, this pattern of 'monopolizing' agency is ubiquitous in the domain of science and technology-based decisions. In fact, the 'fundamental problem of democracy is quite simple: the survival of agency in this increasingly technocratic universe' (Feenberg, 1999, 101). Or to be more precise: the survival of a fairly distributed agency.

In the healthcare sector, for example, access to diagnosis and therapy is often costly, a circumstance that prevents or makes it difficult for many people to receive treatments they need. Continuously rising medical costs are caused, among other things, by the demand for increasingly sophisticated technologies (Wolbring 2005). On occasions, the difficulty in accessing medical care is geographical; in some areas the distance to hospitals and qualified personnel is considerable. There are also cultural reasons that limit people's agency with respect to medical problems: the most extreme are religious prohibitions, but there are also subtle ways of imposing interpretations of health and the nature of disease and how to manage it. Contemporary societies in rich countries are more and more dependent on –and demanding of—technological fixes to their health problems. Technologies in the healthcare system are everywhere: diagnosis, treatment, management and even mass-media coverage of health issues. Not surprisingly, nanotechnologies are vigorously entering the healthcare domain. In the European Union, the United States and other countries, an enormous amount of economic resources is being invested in R&D projects (public and private) in nanomedicine. This concept covers a vast and heterogeneous array of devices, systems and treatments whose common trait is that they are all based on research at the molecular level. This includes drug delivery systems, nanosensors, imaging and simulation systems, implantable materials and devices, nanoparticles for cancer cell detection and destruction, etc. Most of the applications are still in development, although some of them are already in use (Wolbring 2005).[4]

3. Nano-agency: on representing nanotechnologies

There are at least three kinds of 'nano-agency' involved with nanotechnological representation: (1) the agency of the laboratory; (2) the agency of the innovations; (3) and political agency. The so-called 'transfer' of knowledge and artefacts from R&D teams to industrial environments and to society at large can be better conceived as a process of reciprocal mediation between these three kinds of agency. The power of a nanotechnology to 'transform the world' depends on how successfully the three dimensions reinforce each other in a dynamic of 'self-vindication' (Hacking 1983).[5] But how does this dynamic work? Essentially, it has to do with the production, enactment and management of representation. In other words, the nano-network --or a part of it-- represents itself and at the same time acts for, or in the place of, others. It acts as a representative or agent. This representation is both epistemological and political (Flyvbjerg 2004). Just as the researcher speaks and acts for the nanoparticles, for instance, the public decision-maker speaks and acts for society. The researcher represents a group of

[4] For the EU R&D on medical nanotechnologies, see the European Technology Platform Nanomedicine website
http://cordis.europa.eu/nanotechnology/nanomedicine.htm

[5] The concept of self-vindication was originally proposed by Ian Hacking to explain some relevant features of laboratory research. It seems promising enough to extend it to cover all facets of nanotechnological transfer.

nanoparticles in his/her laboratory because he/she produces them, creates and adjusts new microscopes and other technical artefacts, obtains a symbolic (mathematical, visual) representation of nanoparticles and nanostructures, seeking their 'collaboration', making them act in the desired way. If these operations are successful, then the researcher gains a sort of political legitimacy to represent the nanoparticles. This new dual representation, epistemological and political, becomes part of the chain of representations needed to accomplish a nano-innovation that works outside the laboratory in the 'real world'. Other 'strategic actors' - such as promoters, developers and regulators - work on the representations to promote the self-vindication of the network. Political deliberation and decision-making in the usual settings (parliaments, public administration offices, and so on) can enter this process by fostering research and development in its early stages but also, later on, 'legitimizing' the representativeness of the nano-innovations.

Consider the development of technological systems, starting from nanomagnetic particles (e.g. ferric oxide nanoparticles), to be used as markers and destroyers of malignant tumours. These systems attach nanoparticles to cancer cells using magnetic fields, thereby identifying the tumour (in its early stage) and eventually destroying it without damaging adjacent cells or provoking side effects in the organism. It requires a complex set of technical practices for imaging, simulating, producing, identifying and controlling these particles in the laboratory. There are many practical obstacles that have to be overcome in order for these particles to behave in the way the researcher wants them to, before arriving at the developmental phase.

In addition, trials have to be made in order to test the effectiveness and safety of the system, which means dealing with living beings (human or non human). For example, biomedical barriers and the body's immune system have to be overcome, the problem of eliminating the particles has to be resolved, the tissue has to be extracted and the samples analysed, the electromagnetic fields have to be adjusted to the perfect intensity so that they are effective without damaging the subject of the experiment, etc. All this has to do not only with epistemological and technical representations, but also with the ethical side of experimentation (the treatment and slaughter of animals, the informed consent of the subjects of the experiment, etc). Meanwhile, interdisciplinarity has to be managed in order to maintain productive collaboration while avoiding conflict between different scientific and technical cultures;[6] financial support has to be found, and safety issues monitored (accidents, toxicity of the nanoparticles and other products employed, exposure to electromagnetic fields, particles escaping the laboratory, etc.).

In the framework we are presenting, the researcher has to successfully work on all the representational sides of the problem (or at least claim to have done so) before consolidating his/her role as a representative, or in more friendly terms, as a 'delegate'. In fact, the researcher is not the master of the nano-network, but only a part of it. However, as a human he/she supposedly is entitled to 'politically' represent some crucial elements of the network in the context of human society.

The innovation phase adds even more representational chains to those found in the laboratory, concerning, among other things, the institutional and economical framework: healthcare technology assessment, healthcare services, government

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[6] Nanomedical research is conducted by interdisciplinary teams that are often composed by –or need to collaborate with—physicists, engineers of different specialities, computer experts, biologists, chemists, medical researchers, etc.

departments and agencies, companies, and the legal system (especially the patent system). Healthcare workers, healthcare administrators and planners, government officials, businessmen and many others, are (epistemologically-politically) represented in the nano-system for cancer diagnostics and treatment, as long as they are involved in the support and development of the network (its representativeness) or, on the contrary, are opposed to it in some fashion. Therefore, political agency is not a separate phase in the process, but rather it permeates the interplay between the various agencies that define a concrete technological network. But for convenience we can still use 'political agency' to refer to traditional political settings and institutions. Yet in this sense political agency plays an important role from the very start of the process (research support through funding and regulations) and throughout. This allows nanomedical systems and devices to be 'moved' or 'translated' from laboratory to society using 'action plans', governmental support of the private sector in this area, implementation in the public healthcare system, education, dissemination of knowledge about nanotechnological solutions for cancer diagnosis and treatment fostered by public authorities or other customary means.

Patients receiving these treatments also make up part of the network, at least symbolically, in that their voice is heard.

Actually, the process of self-vindication is not completed[7] until there is a 'cultural appropriation' of the nano-innovation (Jamison 2005). This includes the production of 'appropriate' social representations of the technical representations, the creation of a new 'social imaginary' (Taylor 2004) together with new social practices related to the innovation.[8] New, ambivalent images of health, well-being and human enhancement are emerging around nano-innovations. Propitiated by the dominant trends to medicalize and objectify the human body (Wolbring 2005), nanomedicine represents, on one side, the hope of developing 'kinder', less invasive treatments (like vaccines as opposed to surgical procedures, chemotherapy or radiotherapy)[9] and, on the other side, the possibility of profoundly and irreversibly altering certain characteristics of the human body and mind that are traditionally associated with the essence of human nature, including the human genome. This scenario is promising for some (e.g. transhumanists) and a nightmare for others. Different religious and cultural traditions also respond differently to these new technologies (as already happens with conventional ones, such as blood transfusion).

For better or worse, human agency is being extended through the extension of nano-agency (medical or other). Human and non-human agency is 'empowered' through appropriate representational chains that can be directed to accomplish desirable social goals (for example, diagnosis and cancer therapy). However, talking about the endless extension of human agency trough nano-innovations seems mostly a rhetorical device that hides the crucial question of an unfair distribution of that extended agency.

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[7] The completion, of course, is always provisional.

[8] Due to the fact that the vast majority of nanomedical technologies are still in the experimental stage and have not yet entered the market, it is still too early to tell exactly what kinds of social practices will arise around them.

[9] These kinder connotations are evoked by 'lab-on-a-chip' innovations: small diagnostic devices that could be easily used by a person at home, delivering the results of the analysis immediately on a computer screen. However, this kind of approach presents some still unresolved technical difficulties.

Currently, several nanotechnological networks are starting to spread 'over' the social and natural environment. Their expansion gives rise to numerous social concerns, if only because they will probably follow the model employed by other technological innovations, where a tiny but powerful minority decide how they are employed. Obviously, the products of technological innovations can be absolutely successful, total failures or fall somewhere between those two possibilities. But whatever the relative level of success of a product, there is always a possibility that problems will arise. For instance, successful innovations can be a problem if they have a dubious social purpose – such as, nano modified seeds that limit farming freedom or deteriorate the situation of developing countries, surveillance devices that invade privacy, weapons and other military applications used illegitimately by governments or even terrorists. On the other hand, products that do not meet their expected objectives may cause considerable harm; not only economically, but more importantly, in terms of health, safety and the environment.[10] Although these two possibilities (complete success or utter failure) are worrisome, they represent extreme cases. Most likely the majority of products will be 'good enough' to enter the market, although clearly imperfect or simply clumsy. Whatever the end quality of products, the growing concentration of power over new technologies in the hands of a small group of governments and multinational corporations will probably entrench nano-networks in every sphere of society in the near future.

At present, expectations for nanosystems for cancer diagnosis, treatment and prevention are high, just as they are for nanotechnological developments in general due to 'nano-hype'. However, there is no evidence in the recent history of technology that should lead us to presume that miraculous successes will come one after other. In the best scenario, even if cancer diagnosis and therapy proves to be successful in terms of effectiveness, the problem persists of the unequal access to the treatments due to income inequalities of citizens in a specific country or between rich and poor countries in general (what is already known as the 'the nano divide'). Failure to develop efficient and safe nano-tools would have an enormous economic impact as the projects collapse. More importantly, it would frustrate the expectations that patients and their families have on these new technologies, not to mention the obvious loss of human life.

In the most plausible scenario, a few applications will (hopefully) be dramatically successful. Many others will be useless because of unacceptable toxicity or other side effects on the body. Between these two extremes there will be a vast number of products that will be approved and put in use because of the money invested in them and their relative superiority over available alternatives. Unanticipated effects (significant levels of toxicity and unknown side effects that may not be ethically acceptable) or less effectiveness than expected will create a controversy about the legitimacy of the products, a disagreement over the solidity of the network's chain of epistemological and political representations.

4. Detrimental effects of the self-vindication process

Further observations are necessary in order to understand what we mean by the success or failure of a nanotechnological innovation. We need to interpret this pragmatically, as a reinforcement of the self-vindication mechanism. First of all, there is no 'external' criterion to judge success, unless the criterion is advanced by

[10] See Renn and Roco 2006 for an analysis of the present deficits of the risk governance system for nanotechnology and the need for a new framework.

actors not functionally connected to the network. But these actors have to be connected to at least a part of the representational chain that defines the innovation. In other words, judging 'from outside' entails producing alternative representations that dispute some representations of the nano-innovation because these representations are epistemologically incorrect or morally suspect to other actors.

The mechanism of self-vindication itself is not the point here. Any innovation requires some degree of self-vindication in order to have a chance to be successful. The self-vindication may also include a social proposition so appropriate that it does not raise severe ethical and political problems. From a normative point of view, self-vindication must be criticized only when it becomes a hypertrophied defensive mechanism that fights against 'external interference', including any sort of social participation. A network of representations defining an innovation that imposes itself by any means on 'internal' and 'external' actors may be very effective in surviving and extending itself. Still, it is open to criticism for ethical and political reasons. Thus, it is worthwhile to try to elucidate the self-vindication mechanism of representations of an innovation in order to introduce socially desirable elements (Callon, M. et al., 2005.).

Following the strategy of other technological networks, those constituted around nano-devices for cancer diagnosis and treatment will defend their virtues while minimising the problems associated with them and trying to silence their critics. Critics of these technologies have to make arguments based on scientific, technical, ethical, etc. reasons that prove that it is inadvisable to allow them to proliferate; at the very least, critics should propose measures that can be taken to improve them. For example, the following issues will be questioned: what represents an acceptable risk for the patient or insurers,[11] what level of toxicity is acceptable or if the available alternatives are superior taking into consideration criteria such as efficiency, innocuousness, cost and others. But there will also be emotional appeals made to the right of patients to receive an effective treatment, incentives given to medical practitioners, political lobbying, media propaganda, not to mention businesses trying to dominate the industry and struggles between states to obtain strategic advantages in the sector, etc. (ETC Group 2005). It is obvious that we are going to witness a dispute over the strength and quality of network representations that will not, however, be conducted under the ideal terms of a Habermasian debate. More likely many different rhetorical elements will be employed and probably other less respectable means of persuasion.

In this regard, the main objective is not to simply replace 'closing down' possibilities associated with a particular innovation trajectory with an 'opening up' attitude (Stirling 2005). Both closing down and opening up can be desirable depending on the circumstances and the objectives. For instance, an innovation network may try to open up courses of action because it requires a certain flexibility to adapt to unforeseen challenges. On the other hand, from a social perspective, closing down a process is often the most desirable action. In some cases, there exists the necessity or convenience of 'partial closings' in a long process. It is also important to take into consideration the demonstrative value of examples (concrete achievements to discuss), which is not the same as creating a policy based on realities that have already been imposed on society. In our example, that means that early public debate on the virtues and disadvantages of

[11] To get an impression of the point of view of insurance companies see the report by Allianz-OECD International Futures Programme 2005.

nano tools for cancer diagnosis and treatment has to be fostered, but at the same time, some concrete applications in this area should be developed (as is presently occurring) in order to persuade citizens that they are a real hope for curing their diseases and not merely science fiction.

So the main problem arises when the self-vindication mechanism tends to 'control' the specific resources used to either open up or close down possible actions. For instance, a nanomedical network can exploit participatory methods, among other elements, in order to reinforce its legitimacy. What is really at stake here is the empowerment of social agency, a necessary condition of which is the guarantee of fair representation -- no matter if it is to open up or close down a decision making process. In order to guarantee fair representation it is important to properly understand each self-vindicating chain in all its complexities. Moreover, no element of the representational chain should be ignored, human or non-human.

5. Methodological recommendations

We suggest employing a 'genealogical methodology' to analyse the dynamic of self-vindication (Foucault 1971, West 1989); this methodology would closely monitor each project already underway in order to understand how a nanotechnological network (including knowledge, technical expertise, artefacts, institutions, human actors, natural objects, etc.) combines epistemological and political aspects of representation. If basic ethical principles and policy recommendations are derived from a broad consensus they can be legitimately applied to the unexpected problems that will inevitably arise with the advance of each nanotechnological project, from research and design to implementation and eventually to commercialisation. Yet abstract, over-idealised, general approaches will be of little practical use. We need a precise step-by-step and case-by-case knowledge of the 'nano-networking' process for recommendations elaborated in this way to have any possibility of being applied; even more so if they are to be truly effective (de Cózar 2005). The results of these genealogical studies can be further used as input to the social debate (Flyvbjerg 2004).

We should also consider the following initiatives:

- Creating more science-shops and strengthening community-based research in general.
- Combining conventional, formal, representative procedures with existing participatory methods (for example, nano-juries[12]), while also including activism and social movements. However, the integration of these various elements should not be forced into a supposedly all-purpose problem-solving method
- Creating *forums hybrides* (hybrid forums) (Callon, Lascoumes & Barthe, 2001) — an organisational methodology designed to manage scientific and technological controversies in which diverse (human) actors participate.
- Essaying different spatial-temporal scales and trying to 'integrate' the results, since the problem of scale has no single solution.
- A continuous evaluation is necessary rather than isolated actions: evaluation and participation in each phase of the nanotechnological process (broad conception of technological transfer).

[12] For a comparison of different public participatory projects on nanotechnology see the Report 1 by the Nanotechnology Engagement Group.

- Learning from Participatory Technology Assessment (PTA). PTA proposes an exhaustive evaluation of each technological innovation with the early and continuous involvement of society. The main advantage of this approach is that it combines both epistemological and political aspects, because an effective evaluation has to consider both.[13]

These initiatives –together with others—may help maintain a high degree of versatility and reversibility in the technological network, that is, to protect individual and collective agency from imposed decisions on technological trajectories. A simple way of posing this in our example is: to offer citizens enough technical alternatives for cancer diagnosis through public deliberation conducted with the appropriate guarantees. (Of course, what 'enough' means here is also a matter of discussion.)

As said earlier, we are aware of the dangers of idealising participatory mechanisms. Still, when these mechanisms are criticized because they can be manipulated or they are ineffective it is done on the assumption that there are ethical and political criteria which support the criticism. In other words, some normative framework is in order.

6. Pragmatic deliberativism

The approach defended here is similar in spirit to the one Bruno Latour promotes in his most recent work (Latour 2004, 2005, 2005b). Latour urges us to broaden representation to include other people, living beings, artefacts, issues, 'things' (or, alternatively, to give them a chance to exclude themselves from an undesired representational arena). He also praises being sensitive to all possible combinations and arrangements, not only traditional Western political formulae. However, Latour's approach can be vague and formulaic. It seems more like a celebration of the great variety of 'assemblies' that can be put together rather than a systematic treatment of the problems posed by representation and provision of specific criteria for resolving those problems. Despite Latour's protests to the contrary, it lacks, so to speak, a resolute normative stance. Fortunately, this normative add-on can be found in another neo-pragmatist approach,[14] one that comes from a field often despised by Latour: political philosophy.

Epistemological representation is imperative for scientific and technological policy. Today's serious political and environmental problems will not allow us to stop looking for the truth, even if that truth is only tentative. In fact, claims to truth are always an essential component of political representation; but too often appeals to theoretical and practical knowledge are based on elitist, technocratic, anti-democratic premises. In order to combat abuses of this conception of epistemic representation and foster its useful role in decision making on public policy, we need to find an approach that directly addresses the problem of the 'epistemic legitimacy' of political representation. 'Pragmatic deliberativism' (Talisse 2004) can

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[13] Furthermore, PTA methodologies have been tested on numerous occasions, especially in Europe, employing many instruments that facilitate public participation (Klüver et al. 2000).

[14] In many aspects, Latour can be defined as a sort of 'French neo-pragmatist', although explicit recognitions of his debt to American 'classical' pragmatism do not abound in his writings.

be part of the solution. This position is committed to an epistemic understanding of deliberation. Pragmatic deliberativism acknowledges that the primary source of political legitimacy must be epistemological, while avoiding a technocratic interpretation of that recognition.

Pragmatic deliberativism begins with the assumption that the epistemic quality of the results of democratic deliberation is an essential component of their legitimacy.[15] This is the structure of the argument:

1. To believe *p* is to hold that *p* is true.
2. To hold that *p* is true is to hold that *p* can meet the challenges of reason, argumentation and evidence.
3. To hold that *p* can meet these challenges is to engage in the process of justifying it.
4. As individual epistemic capacities are fallible, this process of improving our knowledge is a social endeavour.

In other words, everyone is responsible for his/her assertions. 'To assert that *p* is to incur a set of epistemic obligations associated with justifying or defending *p* against questions, challenges, and countervailing evidence; that is to say, to hold a belief is to be prepared to engage in inquiry concerning that belief […] to be a believer is to be a truth seeker, to be a truth seeker is to be an inquirer, to be an inquirer is to be a reason giver, and to be a reason giver is to be a reason exchanger.' (Talisse, 2005, 104)

In order to assert that a nano-diagnostic tool will soon become an effective, easy, safe and cheap way of diagnosing cancer the speaker must be prepared to publicly defend his/her assertion using the best reasons he/she can find to support his/her claim. The speaker must also be willing to contemplate others reasons and engage in a 'public investigation' about the matter. As a result, the political and epistemic qualities of the collective representations of this nano-tool will eventually improve, although this improvement may be done at the expense of the speaker's original position.

In this theoretical account, anti-democratic conceptions of knowledge are rejected on the basis of a pragmatist and fallibilist epistemology. At the same time, some crucial connections between scientific research and 'social inquiry' are highlighted; both are cooperative, 'problem-solving', self-correcting and yield provisional outcomes, and both are never-ending processes.[16] But scientific-technological research and democratic practice not only share –or should share-- some important features. More interesting –and this point is not explicitly noted by pragmatic deliberativists such as Talisse— representation circulates in both directions between

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[15] Pragmatic deliberativism is explicitly influenced by several Peircean insights about the inescapable communitarian character of 'inquiry', but also closely resembles Dewey's conception of democracy as an endless social experiment. For Dewey, modern technological challenges and the social transformations they bring about represent an opportunity to improve public participation in political life.

[16] Eric Macgilvray has elaborated another interesting proposal that finds in the pragmatist tradition the tools to overcome the limitations imposed on the actions of citizens in a world where increasingly extended and powerful political and economic systems dominate. According to Macgilvray, democratic respect for other points of view cannot prevent citizens from questioning and testing other beliefs in practice (see Macgilvray 2004).

scientific-technological domains and the more traditional political settings. There is a crucial continuity in the 'chain of representations' that, if successful, produces the 'self-vindication' of a network of epistemological and political representations. The 'problem solving' dimension here is twofold: first, to give effective solutions to the problem at hand (cancer diagnosis and therapy) and second, to solve the problem of the legitimacy of the network itself (in our example, briefly put, the legitimacy will come by means of a combination of effectiveness and social acceptability that is eventually reflected in the regulatory framework as authorisations for the commercialisation of products, treatments, and so on).

So, what is the main difference between Latour's approach and Talisse's? In both cases, it is understood that agency becomes a central element of the representative mechanism. (In Latour's terms, insofar as agency is the impulse and expression of new assemblies forged around things; in Talisse's, particularly as deliberative chains of action.) In both cases, it is also mainly a problem of self-vindication, that is to say, of successfully connecting the epistemological and political sides of representation by means of chains of agency (or 'performative chains'). But in the normative stance, success 'at any cost' is unacceptable, especially if the outcome is an increase in the asymmetrical distribution of agency. On the contrary, the success of the network must be based upon the quality of representations understood simultaneously in the epistemological and political sense.[17]

7. Concluding remarks

Whereas Latour's work, along with what we can loosely call other "actor-network-like approaches", give us a rich and complex picture of the vindication phenomena that arise around epistemological and political representational chains, pragmatic deliberativism provides us with the specific normative stance that they lack. It is interesting to find ways to apply a combination of both approaches to the 'management' of nano-innovation, where technological transfer is understood in a broad sense, including a cluster of aspects that go beyond formal political settings without invalidating them.

In summary, this paper proposes using 'agency' as a central concept for investigating representational matters because this approach (1) utilises the fundamental trait that epistemological and political representation have in common: both can be analysed in terms of 'nodes' where different kinds of agency come together and at the same time they are themselves both products of agency that unleash successive chains of actions; (2) it also allows us to understand the mechanism of self-vindication used by representational scientific and technological networks; (3) it minimises the anthropocentric bias in discourse about representation since it acknowledges non-human agency; and (4) it fosters public participation mechanisms in the deliberation of scientific and technological issues.

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[17] Of course, it is debatable whether this interpretation of Latour's last intellectual phase is charitable enough. To the extent that Latour points out the insufficiencies of purely formal representative procedures in order to advocate an object oriented democracy, where assertions must be scrutinized in the public arena, the quality of representations can be considered as a crucial element in his account. Even so, there are some reasons to wonder if Latour has gotten rid of his early tendency to overstate the deployment of power strategies to achieve victory in a quasi-Machiavellian vein.

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