Building on faults

Tommaso Venturini

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How to Represent Controversies with Digital Methods

Tommaso Venturini (Public Understanding of Science, Forthcoming)

Abstract: *In a previous article appeared in this journal, I[1] introduced Bruno Latour's cartography of controversies and I discussed half of it, namely how to observe techno-scientific controversies. In this article I will concentrate on the remaining half: how to represent the complexity of social debates in a legible form. In my previous paper, we learnt how to explore the richness of collective existence through Actor-Network Theory. In this one, I will discuss how to render such complexity through an original visualization device: the controversy-website. Capitalizing on the potential of digital technologies, the controversy-website has been developed as a multilayered toolkit to trace and aggregate information on public debates.*

Keywords: *cartography of controversies, digital methods, web cartography, information visualization, scientific controversies, representations of science, public understanding of science, actor-network theory*

No exploration without representation

The cartography of controversies is a set of techniques to investigate public disputes especially, but not exclusively, around technoscientific issues. It was introduced by Bruno Latour as a didactic exercise in Actor-Network Theory (ANT), but it gradually evolved into a full research method thanks to the contributions of a large research and teaching community[2]. Documenting such method is the aim of this article and of a previous work published in this journal (Venturini, 2009). In that paper, I discussed how to observe controversies through an ANT approach. In this paper, I will propose some descriptive techniques. To be sure, such distinction is largely artificial. In social

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[2] Many of the ideas presented in this article derive from discussions occurred in the European research project MACOSPOL (MApping Constroversies in Science and technology for POLitics - http://www.mappingcontroversies.net/) or in the "Cartography of Controversies" course at Sciences Po Paris. The specific contribution of this article to this collective effort consists in documenting a specific practical device for controversy mapping - the controversy-website - as well as its conceptual basis. Special thanks to Verena Paravel (see demosciences.org) who is doing an amazing job in gathering and reviewing hundreds of digital resources for controversy mapping.

cartography, observation and description always come at once. To explain why, let us run through some of the concepts introduced in my first paper.

According to the cartography of controversies, public debates (vaguely defined as *situations where actors disagree*) constitute the best settings for observing the construction of social life. In controversies, actors are unremittingly engaged in tying and untying relations, arguing categories and identities, revealing the fabric of collective existence. As it takes advantage of the multiplicity of viewpoints that emerge in controversies, social cartography has no reluctance to address their complexity. Certainly, such commitment has drawbacks. Encouraged to multiply viewpoints and perspectives, to contrast notions and methodologies, to explore the social where it gets most complicated, scholars are soon submerged by complexity. Each part claims its exception and the sum of the parts turns out to be greater than the whole.[3]

Left alone, observations in social cartography quickly become too complex to be managed. That is why the task of *unfolding the complexity* of controversies should never be separated from the task of *ordering such complexity*. There is nothing particularly original about this idea. Exploration and representation always come together in cartography. No serious cartographer would travel a territory without taking notes, sketching plans, amending previous atlases. This is how maps have always been manufactured: through a recursive adjustment of observations and descriptions.[4] The same holds for the cartography of controversies. Social cartographers should work out their observations and descriptions at once. Right from the beginning of their campaigns, they will deal with maps. At first, such maps will be rough and incoherent. Yet, these initial and tentative sketches will support observation and facilitate their amending.[5]

To say that no chicken comes without its egg, however, does not mean that chickens and eggs are one thing. Though always performed together, observation and representation should not be confused. As illustrated by Borges' novel on the exactitude

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[3] If there is something that distinguishes the cartography of controversies (and ANT) from a theory of complexity is that it does not believe that order could emerge spontaneously from disorder. Order can indeed be obtained, but only at the price of a collective work of construction and maintenance. Such work is the object of social cartography.

[4] Such relation is analogous to the one that links hypothesis and verification in experimental sciences. Rarely scientists postulate their theories before assessing them in experiments. More often, models and observations are developed together through an iterative tuning. On the connections between representations and sciences see Giardino and Piazza, 2008 (p. 99-134).

[5] Franco Farinelli, 2003 (especially p. 12-23) suggests that the progressive approximation of representations and referents should be considered as a two-way movement. The correspondence between map and territory derives not only from the adjusting the map to territories, but also from using the map as a model which the territory is progressively adjusted to.

of science, nothing is vainer than a map tracing its territory point by point[6]. The map is not the (observed) territory, neither should it be. This is especially true for controversy mapping. What would be the interest of such method if it could just deliver a reproduction of the observed phenomena? To be of any use, social maps have to be less confused and convoluted than collective disputes. They cannot just mirror the complexity of controversies: they have to make such complexity legible.

This is true when controversy mapping is practiced as a pure academic effort, but it is even more true when cartographers aspire to contribute to public debate. If we want social cartography to address any public larger than the STS community, we have to be realist: there is a limit to the time that people can devote to controversies. Precisely because they are constantly busy in fighting their own battles, people are reluctant to dedicate attention to other issues. To use the words of an eminent pragmatist thinker:

> The public will arrive in the middle of the third act and will leave before the last curtain, having stayed just to long enough perhaps to decide who is the hero and who the villain of the piece. Yet usually that judgment will necessarily be made apart from intrinsic merits, on the basis of a sample of behavior, an aspect of a situation, by very rough external evidence (Lippmann 1927, p. 55).

Readers may have noticed a slight contradiction in my argument: first I claimed that sociological observations must be as complex as possible, then I add that observations must be coupled with descriptions, and now I am saying that descriptions must be as simple as possible. But how can simple descriptions fit complex observations? As readers may expect, there is no straightforward answer to such question. In my previous article, I reported that, when questioned about his cartography, Bruno Latour answers nonchalantly: "just look at controversies and tell what you see". I explained why this makes the observation incredibly difficult. It is now time to turn to description and reveal that it is not a bit easier.

Building quakeproof representations

In my previous article, I introduced the notion of 'second degree objectivity'. Unlike positivistic 'first-degree' objectivity, second-degree objectivity is not interested in identifying the *matters of facts* that arouse everyone's agreement, but rather in revealing

[6]"The Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that that vast Map was Useless, and not without some Pitilessness was it, that they delivered it up to the Inclemencies of Sun and Winters" from *Of the Exactitude in Science*, 1946 (English translation in J. L. Borges, *A Universal History of Infamy*, Penguin Books, London, 1975).

the full range of oppositions around *matters of concern*[7]. "Just observe" means remaining open to all perspectives. The same holds for "just describe" but with a crucial refinement: being attentive to all viewpoints does not mean granting everyone the same status.

Beginners often mistake second-degree objectivity for dumb impartiality. Confronted with the evolutionism-creationism debate, for instance, they assume that both sides should be treated in the same way. This talk-show idea of equity has nothing to do with social cartography. Putting evolutionism and creationism on the same level is the surest way to misunderstand both. If this controversy is engaging, it is precisely because it opposes two diverging cosmos. Imposing them the same treatment is disrespectful at best. Objectivity does not come from crediting the same weight to all perspectives, not even from balancing the space allotted to each side[8]. Second-degree objectivity comes from attributing to each actor a representation that fits its position and relevance in the dispute.

Being proportional in social cartography means giving different visibility to different viewpoints according to, 1) their representativeness, 2) their influence, 3) their interest.

(1) The *representativeness* of a viewpoint depends on how many actors subscribe to it. A statement or an argument shared by many of the actors of a controversy deserves more visibility that one that is relatively marginal. For example, in describing climate controversies, it would be misleading to give the same weight to the Intergovernmental Panel on Climate Change and to the Global Climate Coalition. To be proportional in description means conveying that scientists believing in global warming are ten times more numerous than their opponents. This does not mean, of course, that skeptics should be neglected. Not only because the goal of controversies mapping is to present as many viewpoints as possible, but also because representativeness is a matter of weighting much more than of counting. Yet, maps should avoid flattening the landscape of public debate. Not all perspectives are equally supported and social cartographers should find ways to render such disparity.

(2) When advised to consider a negotiation with the Pope, Joseph Stalin sarcastically replied: "the Pope? How many divisions has he got?" (as quoted by Winston Churchill in *The Second World War*, 1948, vol. 1, ch. 8). We now know that this was not a smart answer. The numbers of supporters or allies a viewpoint can mobilize is not the only criterion for deciding its relevance. Controversies have centers and peripheries, reliefs and valleys, frontiers and passes. In such territories, not all positions are equal and actors fight to build and occupy influential positions: positions that give them the power

[7] On the distinction between matters of fact and matters of concern see Latour, 2004.

[8] On the impossibility of being impartial by being symmetrical in the description of controversies see Scott, Richards and Martin, 1990.

to affect the actions of other actors. Actors occupying influential positions deserves a special attention because, like it or not, they will have better chances to shape controversies.[9] That is why, for example, to describe climate change negotiations it is important to relate not only the viewpoint of national leaders, but also that of the most influent NGOs and transnational corporation. Without the support of these actors, no agreement over global warming would have the littlest chance to succeed.

(3) If representative and influent viewpoints should have a central place in social cartography, they should not fill up the space of representation. Controversy mapping cannot content itself with *majority reports*, as the very rise of disputes depends on the presences of *disagreeing minorities*. It is disagreeing minorities who bring controversies into existence by refusing to settle with the mainstream and reopening the black boxes of science and technology. No matter how marginal, disagreeing viewpoints can be interesting because they offer original perspectives and question what is given for granted. Something that is very visible on a map is not necessarily very visible in the territory (this is the very basic of treasure hunting). Cartographers may legitimately choose to be proportional to interest instead of size.

By suggesting three different criteria, social cartography allows scholars to adjust the notion of proportionality to their research goals. Researchers can focus on a sample of representative actors or concentrate on the most influential or spotlight marginal viewpoints, *as long as they can justify their choice*.

This is not just a question of formal justification. In exploring disputes, scholars venture to the thorniest of collective territories. In my previous article, I used the metaphor of magma to illustrate the bubbling nature of controversies. On such perilous flow, cartographic representations float as tectonic plates, colliding with the accounts provided by opposing actors, sinking under weaves of quarrels, melting in the heat of conflicts. Representing a controversy is like building on a seismic fault. To endure the shake of disputes, descriptions must be quakeproof. The building metaphor suits perfectly the cartography of controversies. In mapping, as in building, resistance is obtained by three precautions:

(1) **Adaptation**. To stand on an uneven ground, constructions must adapt to the irregularities of the terrain. In controversy mapping, the first cause of instability is the reflexivity of the involved actors. Contrarily to what many social scientists believe, they

[9] In ANT jargon, the distinction between representativeness and influence is captured by the notions of *spokesperson* and *obligatory passage point* (see Callon, 1986). A spokesperson is an agent who claims to speak in the name of many others. Such claim, of course, is constantly subjected to the acquiescence of the represented, which can in any moment disavow their representatives. An obligatory point of passage is a focal position in a network, a point through which agents are forced to pass because of the configuration of the network.

are not the only ones representing collective phenomena: actors themselves are constantly striving to account for the worlds they live in. Overlooking 'native' representations is the surest way to draw useless maps. Not only must cartographers have the greatest respect for actor's accounts, but they should consider such accounts as their construction ground. For sure, it is a patchy ground, a thin crust cracked by oppositions and conflicts and yet it is the only buildable surface over the magma of controversies. Resting on a patchwork of conflicting representations, cartographic constructions should remain as *flat* as possible. They should stretch to cover as many native representations and overlay as least interpretative layers as possible. A skyscraper of interpretations is the last thing to build on a seismic ground.

(2) **Redundancy**. The need for covering as many 'native' representations as possible seems to contrast with the need to keep representations readable. How is it possible to fit a plurality of opposing accounts in a single and simple map? It is not, indeed, but no one ever asked cartographers to produce just *one* map. The key for drawing effective representations is drawing many of them: each one dedicated to a different aspect of the phenomenon. Even if each map fails in capturing the richness of the disputes, all together they may do the trick. Of course, this implies that many pieces of information will be repeated, but that is not embarrassing. Quite the contrary, redundancy stabilizes representations and makes them able to stand the quakes of public debate.

(3) **Flexibility**. Even more than redundancy and adaptation, controversies mapping need flexibility to cling to the shacking ground of controversies. Collective disputes can only be described by maps that are supple enough to adjust to their dynamism. In a famous paper dedicated to the construction of scientific facts, Bruno Latour showed that objectivity does not depends on the resemblance between the representation and the objects, but on the possibility to move from one to the other. Few are the natural or human phenomena that actually *resemble* a scientific paper, a diagram or an equation. Yet, such expressive media can be connected to the phenomena by a long chain of transformations. The crucial property of such chain, the one that guarantees its solidity, is the possibility to retrace the sequence of translations all the way back to the original phenomenon:

> An essential property of this chain is that it must remain reversible. The succession of stages must be traceable, allowing for travel in both directions. If the chain is interrupted at any point, it ceases to transport truth − ceases, that is, to produce, to construct, to trace, and to conduct it (Latour, 1999, p. 58).

The possibility to move through the chain of a scientific representation assures its flexibility. It allows other scholars to inspect each link of the chain and propose corrections or alternatives. This is the flexibility needed by social cartography: reducing

the richness of controversies (to increase their readability) should never prevent the possibility to get back to original complexity and propose alternative simplifications.

To sum up, the objectivity of cartographic representations depends on the quantity and the quality of the work spent to build them. What is true for buildings is true for representations as well: the better they are built (the more they adapt to their territory, the more they are redundant and flexible), the more solid they will be.

Going digital

Readers who had the patience to follow my double journey through the observation and the description of controversies may now breathe a sigh of relief. All the recommendations of social cartography have been enunciated:

1. you shall listen to actors' voices more than to your own presumptions;
2. you shall observe from as many viewpoints as possible;
3. you shall not restrain your observation to any single theory or methodology;
4. you shall adjust your descriptions and observations recursively;
5. you shall simplify complexity respectfully;
6. you shall attribute to each actor a visibility proportional to its weight;
7. you shall provide descriptions that are adapted, redundant and flexible.

Readers may legitimately feel discouraged: diving in magma and building on faults might seem impossible enterprises, especially by using the traditional equipment of social sciences. Luckily, in social cartography, there is no reason to be orthodox. In the exploration and visualization of collective debate, the use of original research techniques is not only admitted, but encouraged. In particular, the cartography of controversies turns its expectations towards digital methods.

Until few years ago, social scientists conceived electronic media as new terrains for old methodologies. Researchers employed the traditional equipment of social sciences to harness the novelty of cyberculture, virtual communities, online identities, computer mediated communication[10]. Such honorable enterprise has been somewhat defeated by the speed at which digital technologies have infiltrated modernity. Electronic interactions became so pervasive that they can no longer be conceived as a separate social space. No longer limited to a specific sector, digital interactions are now ubiquitously weaved into the fabric of collective existence. Follow digital threads and social tapestry will be deployed.[11]

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[10] Examples of this literature are Rheingold, 2000 (on virtual communities); Negroponte, 1996 (on cyberculture); Turkle, 1995 (on online identities); Levy, 1994 (on computer mediated communication).

[11] This inversion in the relationship between digital environments and social sciences is exemplified Adamic, Buyukkokten and Adar 2003 and in Rogers, 2004a (see also the web site of his group www.digitalmethods.net)

Digital mediation adds to collective phenomena a couple of properties that are precious for cartographic purposes: *traceability* and *aggregability*. Of course, none of them is unique to digital environments: all theories and methods have been developed to supply the same two properties. Yet, through digital mediation traceability and aggregability become intrinsic affordances of social phenomena.

To *trace* a phenomenon means converting it in a piece of writing. Such process (also known as 'inscription'[12] or 'formalization'[13]) plays a pivotal role in modern science. No matter if you investigate nuclear forces, legal bindings or neural synapses, if you work within the framework of science, you will eventually deal with words, charts or numbers. This holds also for social sciences, whose rationale is to provide formalized accounts of collective phenomena.

Now, the interesting thing about digital media is that everything they mediate is automatically traceable. To be fed into a computer[14] (or to be transmitted through a computer network)[15] phenomena have to be given a logical or mathematical form. There is nothing extraordinary in this remark and yet few seem to realize its consequences. If you compose a poem using a word processor, the versions you go through, the time you spend editing, the words you try, the verses you ponder, all the twists and turns of your inspiration can be easily tracked by your very typing software. The same may happen if you exchange mails with colleagues, share opinions in a forum, seduce someone in a chat. Anything you say or do in a digital environment is traceable and often actually traced.

This fact has a major impact on social sciences.[16] Before the advent of digital mediation, social traceability was limited by amount of resources that could be devoted to the endeavor. As extracting rich data on large populations was too expensive, scholars pulled the short blanket either by restricting the population (through qualitative methods) or by reducing the detail of data (through quantitative methods). In one direction, they floated towards psychological or micro-interactive accounts of social life. In the other

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[12] On inscription and its role in modern science see Latour and Woolgar, 1979 (especially p. 45-53).

[13] On the formalisation of technological knowledge and its effects on innovation see XXX, 2007.

[14] The Association for Computing Machinery defines computing as the "algorithmic processes that describe and transform information" (Denning et al. 1989, p. 12).

[15] According to the insights of Claude Shannon (1948).

[16] As observed by Lazer et al. 2009 "existing ways of conceiving human behavior were developed without access to terabytes of data describing minute-by-minute interactions and locations of entire populations of individuals" (p. 722).

direction, they drifted towards economical or macro-structural approaches. Digital mediation is rapidly rending obsolete such opposition.[17]

Today, masses of thick information can be retrieved on vast populations with a reasonable effort.[18] A scholar interested in, say, agenda-setting is only a few clicks away from the archives of hundreds of newspapers and magazines, the records of television newscasts, the press-releases of institutions and agencies, the full-text of blogs, forums, newsgroups. And that's not all, with a little more effort, she can access the biography and bibliography of anyone who reported the story, the number of times the story has been searched on the Internet, the profiles of all actors involved and so on.

Not only is larger quantity of information accessible, but also new qualities are becoming traceable. Collective phenomena have long been divided in two dimensions: the micro-dimension of face-to-face interactions and the macro-dimension of systemic structures. Although coupled, these two dimensions have been considered as occupying two different layers of collective existence.[19] As syntax and phonetics, organs and cells, molecules and atoms, macro-structure and micro-interactions were considered as two impermeable spheres, one emerging from the other and yet remaining irreducible to it. ANT discarded such distinction as a methodological bias.[20] As scholars had access *either* to the direct observation of situated interactions *or* to aggregated data on global structures, they were led to believe that these were two separate dimensions. The very notion of *actor-network* was introduced to follow collective phenomena without separating interactions from structures.

Easier said than done. Until the advent of digital technologies, no researcher ever had the chance to follow the assembly line of society. Consider a classical economist: she could either investigate a local set of exchanges (microeconomics) or the aggregated data of national assets (macroeconomics), but she couldn't trace the path through which each single transaction contribute to the global economy[21]. Today, credit cards databases as

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[17] According to Michel Callon (2006), digital techniques bring together the advantages of quantitative analysis (the possibility to handle large amounts of data) and of qualitative investigation (the possibility to remain open to the contributions and objections from the studied actors.)

[18] See Jonah Bossewitch (2008) for an interesting review of several digital tools that "can do for the social sciences what the automatic gene sequencer has done for molecular biology" (p. 3).

[19] In sociology, the first author that interpreted the micro/macro distinction as an opposition between two different types of sociality was Ferdinand Tönnies (1887) with his famous *Gemeinschaft/Gesellschaft* distinction.

[20] See in particular Callon, M. and B. Latour (1981).

[21] To differentiate these two types of knowledge, Richard Rogers (2004b) distinguish between tracking ("a package is tracked by recording its arrival and departure at given points along a route") and tracing ("tracing is movement monitoring, an effort to record the full trajectory of the package's journey").

well as supermarkets accountancy can provide insights on this path (and the more people use credit cards and supermarkets, the more such insights become precise).

> The ancient divide between the social on the one hand and the psychological on the other was largely an artifact of an asymmetry between the traceability of various types of carriers: what Proust's narrator was doing with his heroes, no one could say, thus it was said to be private and left to psychology; what Proust earned from his book was calculable, and thus was made part of the social or the economic sphere. But today the data bank of Amazon.com has simultaneous access to my most subtle preferences as well as to my Visa card. As soon as I purchase on the web, I erase the difference between the social, the economic and the psychological (Latour, 2007).

Imagine what this means for social cartography. Thanks to digital mediation, 'observing controversies from all the concerned viewpoints' becomes more than a wishful slogan: it becomes actually possible. With a reasonable commitment and some computer skills, the students in our cartography course can follow controversies through media coverage, scientific literatures, legal indices, economical data and the blogosphere.

Navigating through digital datascapes

The new observation opportunities sown by digital mediation do not necessarily yield better researches. As said, more observation always calls for more representation. The proliferation of data made possible by digital techniques would be unintelligible without a commensurate effort in articulation: traceability is useless without aggregability.

To *aggregate* information means displaying it in a condensed form, transforming data so that few elements become representatives of many other. Several examples can be provided: synopsis and listing in writing, calculation and inference in statistics, diagrams and stylizations in design. All these techniques (and many other) are used by scientists to make complexity readable. Consider a graph showing the increase of a given observable: the clarity of the representation is obtained through graphical operations (tracing a Cartesian plane, setting the points according to their coordinates, drawing the connecting lines), statistical operations (assigning values, classifying data, calculating averages) and literal operations (transcribing observations, paraphrasing transcriptions, comparing paraphrases). Through each transformation, observations gain readability by loosing some of the original richness.

Certainly, aggregation is a risky process: it always entails the risk of dumping something important. That is why the reversibility is so important. It is only by being sure that reductions can be undone. Like Theseus, scientists wouldn't wander the maze of representation without a thread to follow back. By maintaining aggregation reversible,

researchers assure themselves (and their peers) the possibility to climb back their formalizations and try other descents.[22]

To be sure, scientific descriptions did not wait for digitalization to become reversible. Serious social investigations have always offered access to non-aggregated (or less-aggregated) data. Yet, before digitalization, reversing formalizations entailed moving through different supports. Verifying a graph required moving from the chart to a calculator, from the calculator to the data table, from the table to the archive that gathered the notes, from the notes to the sampled population, from the sample to the actual phenomenon. Each step involved different devices and required a considerable effort. With digital techniques, disaggregating becomes much easier as all steps can be performed without taking the eyes off a computer screen.

Consider any of the blogosphere maps available online[23]: not only does it portray the structure of blogosphere (showing central and peripheral nodes), but also it allows tracing the connections of each node and even reading the specific posts where the connections were made. The capacity of zooming through different levels of aggregation[24] is what makes digital representations so convenient for social sciences. Digital mediation fills the observation gap between macro-structures and micro-interactions as it provides means to move from one to the other.

That is not all: not only is digitalization making aggregations chains easily reversible, but it is also gathering different chains in one homogenous space. Today, historians, economists, psychologists, ethnographers (as well as biologists, mathematicians, physicists, chemists…) all use similar personal computers to transform and store data. They all feed data in similar databases, spreadsheets and word processors. Their papers can be found in the same online libraries, download to the same hard disk and read on the same screens. Comparisons and hybridizations among disciplines become more frequent just because all technical obstacles are removed. Once again, this was not impossible before digitalization. Yet, the smoothness of these digital crossings is

[22] It is not just the possibility of falsification that defines science, but the possibility of falsifying scientific representations by the very same data that generated them.

[23] See http://www.presidentialwatch08.com or http://www.observatoire-presidentielle.fr

[24] On the cognitive value of the process of zooming in and out through descriptions (in the case of architectural models), see Albena Yaneva (2005).

startling,[25] especially as a similar process is affecting the boundaries between scientific data and other type of information:[26]

> Owen Gingerich, the great historian of astronomy, spent a life-time retrieving all the annotations of all the copies of Copernicus's first edition… Nowadays, any scientist can do the same for each portion of each article he or she has published so long as the local library has bought a good package of digital data banks. But what is more extraordinary is that any journalist can do so as well for the latest Madonna video or the dirtiest rumour about Prince Harry's love affairs. (Latour, 2007).

Yes, the cartography of controversy has a liking for digital techniques. With their support, the commandments of social cartography seem less extreme and the tasks of being sensitive in observation and legible in description appear less contradictory. Yet, the enthusiasm for digital innovation should not prevent us from acknowledging four simple facts:

1. search engines are not the web;
2. the web is not the Internet;
3. the Internet is not the digital;
4. the digital is not the world.

(1) Even if portals and search engines are constantly expanding their databases, they cannot grow as fast as the web. Every day hundreds of thousands of new pages are created and only a fraction is reached by the search crawlers. Sometimes contents remain invisible because they are too marginal or ephemeral, sometimes because they are concealed by their authors, sometimes they are just forgotten. (2) Even if more and more information is exchanged via the hypertext transfer protocol (http) and under the form of an xhtml page, a large slice of electronic traffic travels through other routes. E-mails, teleconferences, chats, peer-to-peers exchanges, document transfers and many other data do not transit via web protocols. (3) Not all digital information is shared on a computer network and not all networks are connected to the Internet. For every piece of information diffused on the Internet, hundreds of other data are buried inside the memory of offline computers or limited to LANs.[27] (4) Even if in western societies computers are more and more ubiquitous, important portions of collective life remain impermeable to

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[25] After all, it was a incremental improvement in the ease and the quickness of texts reproductions that triggered the scientific revolution (see, Eisenstein, 1983, p. 187-254).

[26] The most known example is the Google Flu project (http://www.google.org/flutrends/) developed by the Google Foundation. By analyzing the temporal trends of the flu-related queries received by Google search engine, the project developed an index that is said to "estimate flu activity up to two weeks faster than traditional systems". In other words, web-statistics may predict flu better that epidemiologic research,

[27] In an interesting essay, Peter Galison (2005) describes the amazing efforts deployed by modern societies to hide documents for security reasons. According to his calculation, the amount of classified documents can be "on the order of five to ten times larger than the open literature" (p. 591).

digital mediation. No matter how pervasive technology will get, face-to-face interactions will never lose their importance. Last but not least, the world is bigger than western societies (especially in an age of globalization) and other societies are proving to be much more resistant to digital penetration.

The 9+1 layers of a controversy-website

The four limitations just listed limit the ambitions of digital methods, but do not diminish their interest. Several web-based tools are now available to support the investigation of socio-technical debates. A large set of these tools has been identified and tested by the project MACOSPOL (*MApping COntroversies on Science for POLitics,*). With the support of European Union, MACOSPOL has brought together eight universities and research centers[28] in the effort of selecting the most interesting resources and the best practices in digital cartography. The result is a platform (www.mappingcontroversies.net) conceived as a toolkit for researchers who want to experiment in digital controversy mapping.

Tools, however, are only half of the story. To be used in a cartographic campaign, tools have to be connected and coordinated. Through MACOSPOL and our teaching experience at Sciences Po, we devised a basic framework for controversy mapping: the controversy-website. Such framework is an atlas composed of nine different layers.[29]

1. **The glossary of non-controversial elements**. Although characterized by disagreement, controversies always grounds on a base of shared notions. Climatologists could not argue about temperature variations if they did not agree on what temperature is and agronomist could not quarrel on GMO if they did not share some taxonomy of plants. Some of these non-controversial elements are so common that they don't need to be explained. Other may hinder the understanding and the participation of the public. Instead of describing in words the procedures of science, it is now possible to actually show them through simulations and multimedia, thereby overcoming the difficulties of specialized jargons.

[28] Sciences Po, University of Munich, University of Oslo, University of Amsterdam, Ecole Polytechnique of Lausanne, University of Manchester, University of Liège, Osberva.

[29] In the next paragraph, I will discuss each of these layers, but many other examples may be found at http://medialab.sciences-po.fr/controversies/guidedtour/

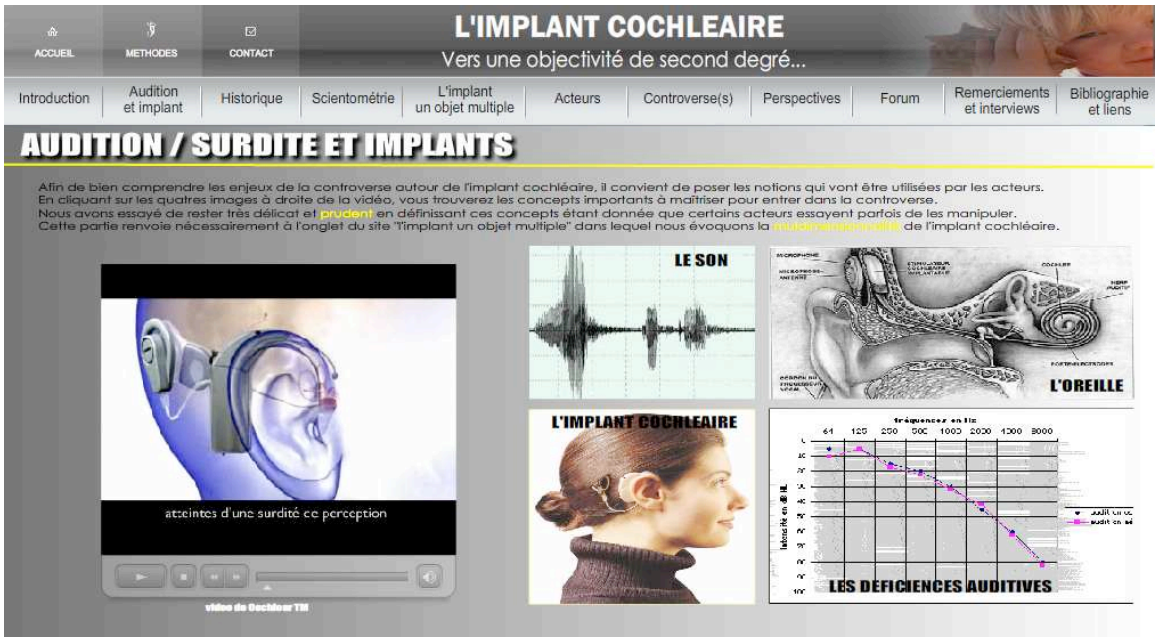

FIG. 1 the glossary of the controversy on audio implants

2. **The documentation repository**. To assure the reversibility of the simplifications, a controversy-website should provide the access to the complete documentation gathered by the study. The minimal costs of online publishing, as well as the fact that most data are collected in a digital form, facilitate their diffusion on the web. Field notes, interview recordings, raw data, archive documents, all traces should be offered to public examination. Analogously, in a hypertextual environment, bibliographic references should provide direct linkage, thereby facilitating the access to the original sources. Thanks to digital environments it is now possible to publish not only the results, but each and every step of an investigation, encouraging the reuse of data and research techniques.

3. **The analysis of scientific literature**. Being particularly interested in technoscientific controversies, social cartography cannot neglect the investigation of scientific literature. Today numerous online repositories allow not only searching and consulting scientific documentation, but also performing several basic scientometric analyses. Scientometrics can reveal the networks of scientific collaboration through the analysis of co-authorship, the relative authority actors (scientists, research centers, journals…) through citation analysis, and the diffusion of ideas through lexicographic analysis. The results of these analyses may be displayed as indicators or as connection graphs. This second method is to be preferred as it allows revealing the opposition and alliances in the scientific community, as well as the existence of disciplinary or institutional clusters.

4. **The review of media and public opinions**. Until few years ago, textual statistics were handmade or limited by the availability of digitalized texts. As a result, the use of lexicographic and graph analyses techniques was restricted to scientific literature or a

small portion of the press. The expansion of digital mediation is extending the scope of such techniques to all types of discourses. News, gossips, opinions, rumors, discussions, quarrels can be followed with the very same tools used for scientific theories. Not only are media discourses, institutional statements and public opinions now traceable, but they can also be presented in the same visualization space employed for sciences and technology. In particular, the theory of graphs and the tools that came with it have been applied to every kind of networks (see Barabasi, 2002 and Watt 2003) thereby supporting the ANT claim on the impossibility to isolate technoscientific phenomena.

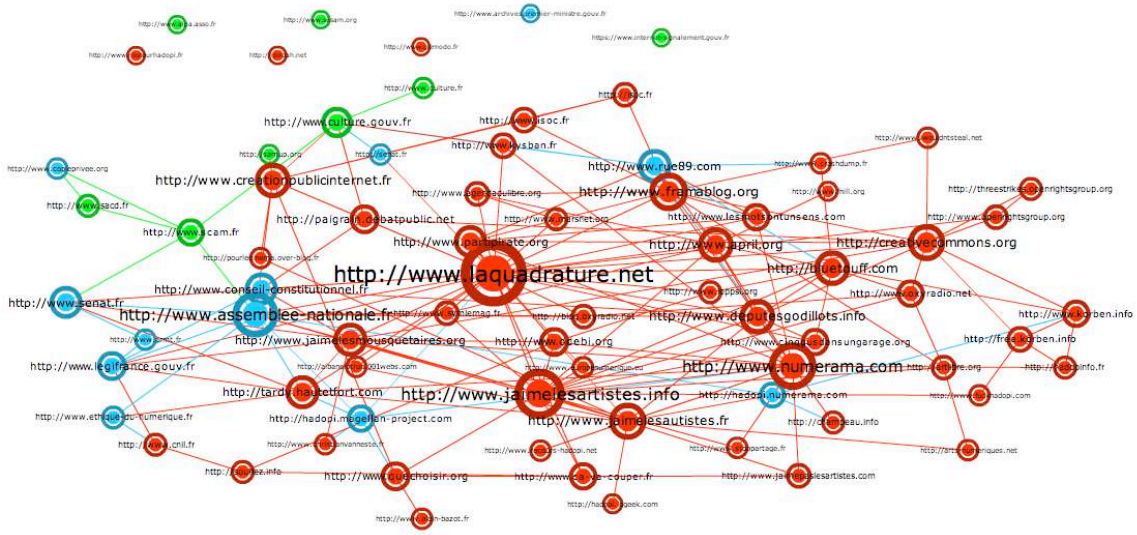

FIG. 2 Map of the controversy around the Hadopi law as it appears on the web.

5. **The tree of disagreement**. No controversy can be reduced to a binary opposition between two alternative viewpoints. Controversies always involve a plurality of different questions and few of these questions can be answered with a simple yes or no. The positions of actors in a controversy are always complicated and nuanced. Still, cartographers should not renounce to trace how arguments are connected and structured in discourses. A position taken on a specific issue limit the positions that could be taken on other issues. This ramification can be represented in numerous ways. However, hierarchical trees (also known as *Porphyrian trees*) proved to be particularly convenient to illustrate technoscientific disputes. These controversies tend to span from most general principles to the most specific details. Hierarchical trees fit perfectly these branching structures, revealing how the tiniest disagreement between actors is often linked to the broadest opposition in social networks (and vice versa).

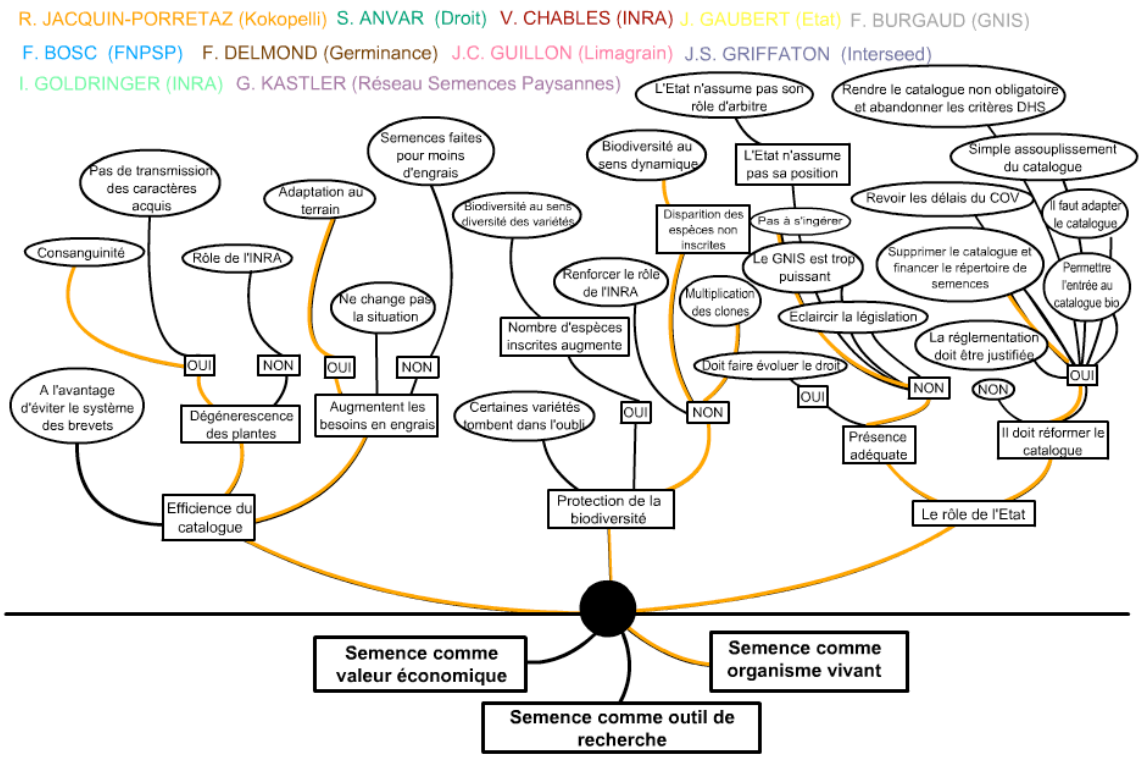

FIG. 3 the controversy on seeds' catalogues and its related questions

6. **The scale of controversies**. No controversy is an island. Take whatever controversies, it will always be composed of several sub-controversies, it will always be connected to several other controversies situated at the same level and it will always be part of one or more super-controversies. Cartographers are free to choose the granularity of their investigation, but they must be able to situate their object of study in the scale of disputes where it belongs. Identifying how controversies are ordered according to their degree of generality-specificity is crucial because the development of a dispute is often affected by events taking place above or below such dispute. The controversy around transgenic agriculture, for example, has been deeply affected by the general debate on the precaution principle as well as by the specific quarrel around epigenetic networks. To be sure, what counts as general and what counts as specific can be completely reversed by the very dynamics of disputes, yet scholars should try their best to show how controversial spaces are organized.

7. **The diagram of actors-networks**. The basic tenet of ANT is that every actor can be decomposed into a network and that every network can be connected tightly enough to become a single actor. What used to be a single actor can suddenly dissolve in an explosion of conflicting agents and what used to be a loose constellation of agents can solidify into a unique source of action. Controversies evolve through this magmatic movement, but this twofold dynamism is difficult to show on paper, because this entails a constant shifting of the sense of the words used to describe actors and networks. The

difficulty to represent the crucial phenomenon of liquefaction-solidification has been frequently reproached to ANT[30]. Digital tools can eventually make ANT intuitions visible by developing animations that render the magmatic flow of social phenomena.

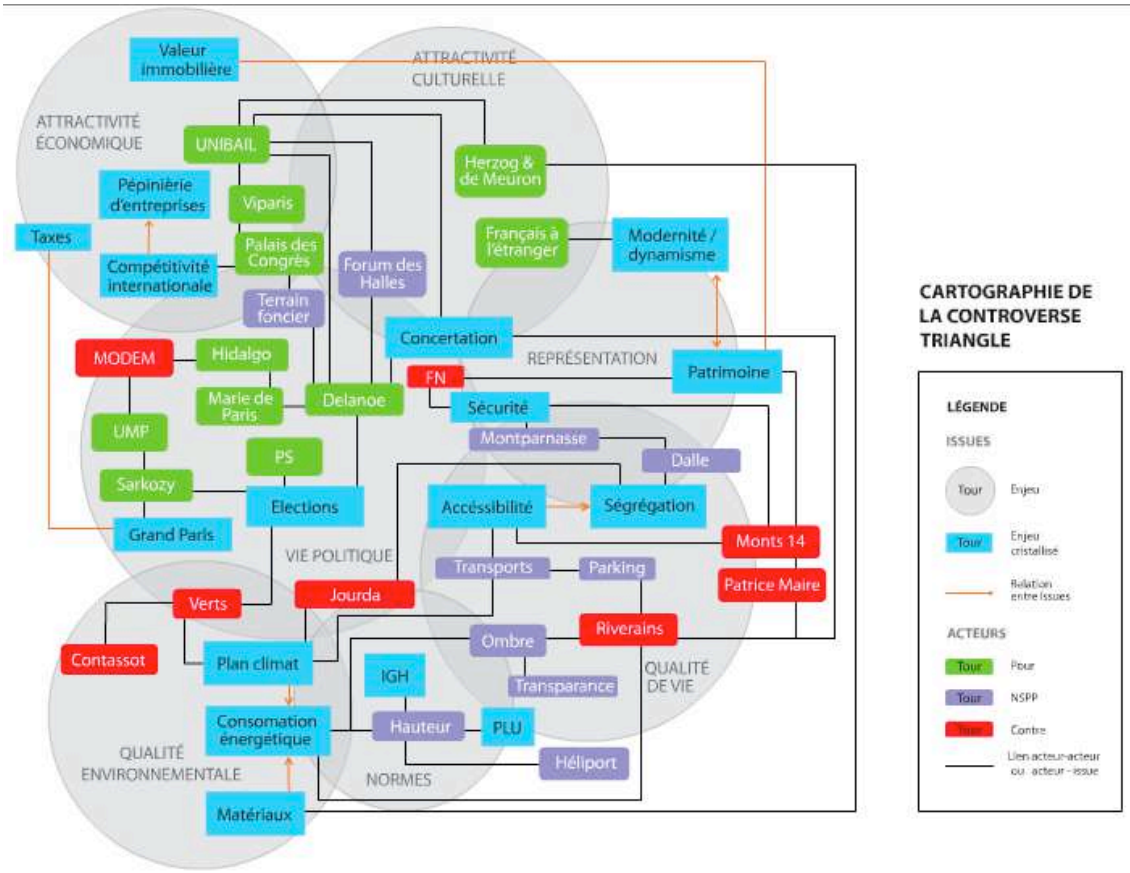

FIG. 4 the actor-networks of the 'Tour Triangle' controversy

8. **The chronology of dispute**. Controversies are, by definition, the most dynamic phenomena of collective life. As such they need to be explored *in time*. Obviously, the evolution of controversies is not uniform: sometime controversies remain dormant for years or decades and then burst in a sudden cascade of quarrels. This makes timelines difficult to draw because most events are packed in short periods separated by long empty gaps. Digital timelines have the advantage of being navigable. Readers can zoom out to get an overall view or zoom in to examine specific events and retrieve further information, multimedia contents or hyperlinks. Event more importantly, digital methods allow to add the time dimension to all the previous layers. Thanks to the interactivity of digital tools, it is possible not only to show the position of actors at a given moment of

[30] This difficulty has greatly hindered the acceptance of ANT: "Critics have often accused these studies of replacing the distinctions and the tools of economy, history and sociology with a bunch of undifferentiated networks (Latour, 1992, p. 419, translation provided).

time, but also to show how it changes through the time and how this affected the definition of the controversy itself.

9. **The table of cosmos**. In my previous paper I discussed the influence that ideologies may have on controversies. To handle the growing complexity of social life, all actors develop simplified interpretation grids. When these grids diverge they often become major communication obstacles in the resolution of controversies. Viewed from different ideologies, the same elements may appear radically different, thereby impeding reciprocal understanding. Unlike what a positivistic approach would suggest, controversies are never just a disagreement on a few technical points. Technoscientific disputes, as specific as they may be, always end up opposing conflicting visions of the world. The table of cosmos should represent all the involved cosmos of a controversy showing where they diverge and where they may overlap.

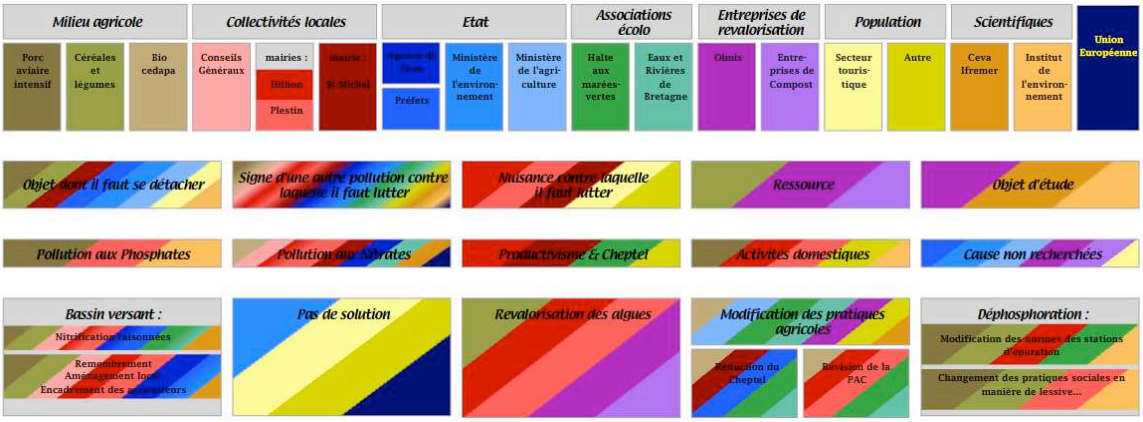

FIG 5. The cosmos opposed by the controversy on algae infestations

A tenth layer exists and is both the most fascinating and the least developed in the cartography of controversies. Besides observing and representing public debates, controversy-websites might also provide a space to *perform* them. If there is one thing that sets the web apart from all previous media, it is the possibility to establish a symmetrical communication among a large number of actors. The web is the only broadcasting media that do not distinguish irreversibly between source and audience. Of course, asymmetries do exist in online communication: it is the owner of a website who chooses which expressive spaces are left to visitors. Still, the very fact that websites' owners are given this choice represents an unprecedented possibility. Interactivity allows involving visitors in the research process, collecting their observations, soliciting their contributions and gathering their comments. At best, through blogs, forums, groupware, wikis, controversy-websites can become the very place where disputes are collectively elaborated and arranged.

According to several scholars working on politics with an ANT approach, the contemporary crisis of political representations is largely due to the difficulty of negotiating modern controversies within the existent public forums. Traditional institutions (such as parliaments, referendums, newspapers) may have difficulties in hosting technoscientific disputes, because they are not issue-specific and because they are incapable of handling enough heterogeneity.[31] Based on heterogeneous observations and issues-centred representations, controversies-websites might become an interesting alternative setting for collective debate, thereby participating to the digital renewal of public sphere.[32] Unfortunately, discussing such intriguing possibility is way beyond the scope of this paper and must be postponed to further researches.

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[31] On the first difficulty of traditional forums see Marres, 2007, on the second see Callon, Lascoumes, and Barthe, 2009. See also Latour, 2005.

[32] See Benkler, 2006 and Hindman, 2009 for two diverging accounts on the extent of this renewal.

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