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Web-Visions as Controversy-Lenses

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Web-based visualizations are increasingly used to study and manage emerging technologies and the controversies they ignite. The first part of this paper provides a methodological review of this trend and presents a typology that organizes influential analytical approaches according to the data they use to generate visualizations; the ontology they ascribe to them and their proposed function. The second part presents ‘web-vision analysis’ as an analytical approach that has roots in different aspects of the reviewed approaches but nonetheless distinguishes itself in two ways. First, it translates the concepts of ‘calculative spaces’ and ‘attention-structures’ from economic sociology into controversy-visualization. Second, it constructs visualizations on the basis of case-study logics. The third part illustrates how this approach ultimately leads to distinct empirical choices by reflecting on the process of constructing and interpreting web-visions of synthetic biology made from January to October 2011.

KEYWORDS controversy, visualization, digital traces, synthetic biology, web-vision

Introduction

Digital traces, such as hyperlinks, are increasingly left by people as part of their communicative practices on the web and this has not gone unnoticed by researchers and decision-makers interested in emerging technologies and the controversies they ignite. Universities, public intelligence units and consultancy firms are attempting to extract meaning from such traces and synthesize them into visualizations that can provide insights into social dynamics around emerging technologies. The analytical approaches behind these visualizations may therefore come to shape the way we, as a society, discuss emerging technologies and draw boundaries around the information deemed relevant for understanding their development.

The first part of this paper provides a methodological review of five influential approaches and presents a typology that organizes them according to the data from which they construct visualizations and the ontological status they assign to them. Even though they share relational and visual metaphors of the social, the review identifies fundamental differences that
indicate various directions for the methodological trend to take. It furthermore shows how these directions are grounded in assumptions about the type of knowledge a visualization can generate and the function it is supposed to serve.

The second part of the paper develops the framework of ‘web-vision analysis’. It builds on a conceptualization of visualizations as filter-driven modes of seeing that has roots in some of the reviewed approaches, but it occupies a distinct position in the typology because of two analytical characteristics. First, it translates the concepts of ‘calculative spaces’ and ‘attention structures’ from economic sociology to controversy-visualization. Secondly, it constructs visualizations on the basis of case-study logics. Both of these steps bring choices about starting points and software-tools into the heart of the visualizing strategy in a way that challenges the ambitions of representation which in different ways underlie the reviewed approaches. The third part of the paper illustrates how these analytical characteristics can guide empirical research through a reflection on the process of constructing and interpreting ‘web-visions’ of the controversy about synthetic biology from January–October 2011.

Analytical approaches to web-based visualization

The visualizations reviewed below depict social dynamics around emerging technologies in different ways. Some are focused on scientific aspects of technology development and others on the public controversies they ignite. But they share methodological roots in a relational view of social science, which highlights relations between entities rather than their individual characteristics (Emirbayer 1997). This leads them to rely on similar visual metaphors of the social such as relational maps of colored nodes connected by lines on a two-dimensional graph. But underneath the similar visual surfaces lie important differences and each visualization reviewed exemplifies a general and distinct analytical approach. Based on the way the visualizations are presented by their authors they will be positioned in relation to each other in a two-dimensional typology (see Figure 4 below).

Explaining the typology

The position of the approaches on the horizontal axis indicates the type of data from which they build visualizations. This choice is highly relevant because web-based visualizations must be initiated from a pool of pre-selected data from which digital traces can be harnessed and synthesized. To the left we find visualizations that are ‘relevance-driven’ in the sense that they are initiated from data that are deemed relevant and reliable in relation to the technology of interest. The selection of starting points is based on knowledge about the technological development that is obtained prior to the construction of the visualization. To the right we find visualizations that are initiated from a specific information-filter deemed worthy of interest. The visualizations are driven by an interest in the specific filter, rather than a belief in its capability to provide reliable data. The knowledge from which the researcher initiates the visualization concerns the filter and not the controversy per se.

The position of the approaches on the vertical axis indicates differences in relation to the ontological status they assign to the visualization. On the top
we find approaches aiming for it to be an ‘objective representation’ of something external. They uphold a distinction between the nature of the represented item and the human choices made in the process of representing it. These choices are supposed to be as unbiased as possible in order for the visualization to correspond to phenomenon represented. The software tools used in the visualizing process are, in the same vein, approached as a medium that optimally allow the represented item to appear without interfering with it. An analogue to this position would be that of a photographer who chooses her angle and lightning with an ambition of interfering as little as possible with the object photographed. In order to explain why a photograph looks a certain way she would refer to the nature of the object photographed (Carusi et al. 2010).

Approaches at the bottom of this dimension are interested in visualizations as ‘socio-technical modes of seeing’ in a way that is more akin to the interests we have in abstract and surrealist paintings. When looking at such a painting the purpose is not to draw inferences about the nature of the object portrayed but rather to get an idea of how it was seen by the painter. We are interested in the mode of seeing and the sense-making it conveys. Whereas sense-making in the case of a painting is often tied to the intentionality of the painter it is more complex in relation to web-based visualizations because they are the result of technological, human and social influences (Carusi et al. 2010). Approaches at the bottom of the second dimension are interested in visualizations as such distributed socio-technical modes of seeing. They have no ambition of distinguishing their shape from the human choices and technological systems that goes into constructing them.

**Filling in the top-left corner**

On the top-left side of the dimension we find the approach of ‘social network analysis’ (SNA), which is interested in the structure of social networks that emerge from the ties that connect humans and organizations. The visualization in Figure 1 is a quintessential example of this approach and it allows for a structural analysis of the communication network that make up the debate about nanotechnology (Ackland et al. 2010).

The nodes are shaped according to a pre-determined typology of organizations and a statistical measure of their centrality in the network is calculated on the basis of the hyperlinked ties between them. The nodes and ties are interpreted as corresponding to clearly defined organizational types and communicative actions and the communicative structure of the debate about nanotechnology is supposed to be represented in an unbiased way. This way of operationalizing a communication network leads to many insights such as that commercial info-sites about nanotechnology are more prominent in the debate than commercial producers of nanotechnology. To ensure that the visualization contains a relevant and comprehensive set of organizations it was initiated from 25 websites listed on the Merril Lynch Nanotech index, which identifies companies that have their future profit tied to nanotechnology. The index was used as a trusted basis from which to visualize the network and the demarcation of relevant organizations is accordingly a consequence of their relation to these relevant ‘seed-sites’.

The approach of ‘webometric analysis’ (WA) is close to that of SNA because it also promotes a macro-structural analysis of pre-defined social actors with
predefined ties. Its position on the top of the vertical axis is unambiguous because it approaches the online as a source for saying something about the offline and interprets hyperlinks as representing a specific form of loose networking between organizations (Thelwall 2009). A recent WA project, for example, aims at representing the scientific field of second generation biofuels. The resulting visualization is presented as evidence of the fact that this field is loosely organized except for the central position of a set of international technology networks through which industrial firms collaborate (Thelwall et al. 2010). The authors explicitly identify the potential biases of this evidence and the ambition is to overcome them in a way that allows WA to get closer to the goal of creating objective representations of the scientific field. Its starting points are 150 web sites that discuss second generation biofuels and they are identified through a triangulation of trusted sources that are subsequently validated by field experts. Sources are only used to the extent that they can contribute to a relevant and reliable sample. The explicit ambitions of correspondence between the online and the offline and the validation of relevance by human experts position WA even more to the top-left than SNA.

Controversy-mapping as a middle ground
‘Controversy mapping’ (CM) is presented as an alternative to visualizations that assume the existence of clearly demarcated actors and ties prior to the mapping. Figure 2 is a well developed example of the approach and it is a
snapshot of a simulation that illustrates how the controversy about the stadium build for the London 2012 Olympics has unfolded throughout time (Yaneva 2012).

The first consequence of not working with pre-defined typologies of actors is that the nodes in the network are not only humans and organizations. The Bird’s Nest stadium of the Beijing Olympics is, for example, an actor that is argued to have had a great influence on the construction of the London stadium. It is a material actor and the inclusion of such actors entails that the ties cannot be social connections between organizations as above. Instead of signifying hyperlinks the ties signify semantic relations between actors and themes in publicly available documents. These semantic relations are less stable than the social relations visualized by SNA and WA and the actors gain their (fluid) identity in the mapping process, rather than through a pre-defined typology. This represents a shift from a mimetic use of maps to a navigational use where the ambition is to make sense of social phenomena rather than to represent them (Yaneva 2012).

With this move CM takes a solid step towards interpreting visualizations as modes of seeing and it positions itself in a tradition of Actor-Network Theory (ANT) where every description is taken to be a constructed and performative intervention (Latour 2010). But CM is not placed at the bottom of the vertical axis because its ambition is to construct visualizations that generate full and extensive controversy-maps. The simulation in Figure 2 is meant to encompass all actors enrolled in the controversy and all of the issues to which the design of the stadium are related. It is explicitly presented as a ‘[…] a new variety of representational techniques [that] simulates reality’ (Yaneva 2012). Figure 2 is, in that sense, an attempt to overcome the opposition between ‘modes of seeing’ and ‘objective realism’ that characterizes the vertical axis.

This is also a characteristic of much work done in the MACOSPOL consortium of which it is a subproject. The initiator of the consortium, Bruno Latour, has been a frontrunner in emphasizing the way maps and descriptions are performative but he has also stated that visualizations of controversies can be almost as precise as the description of a scientific fact (Latour 2007) and that the question of politics should be ‘extended from representing people to representing controversies’ (Latour, no date). The
represantational ambition voiced in these statements is tied to a conceptualization of a fact as the transformation of something material into a figure or diagram that succeeds in being circulated as an argument. A fact is connected to reality through a broad range of observation tools that superimpose many observational layers and multiply many datasets (Latour 2010). In relation to controversy-mapping this is labelled ‘second degree objectivity’ and it is only fulfilled when the full range of concerns around a given technology are revealed in a visualization that attributes each actor a visibility that fits its position and relevance in the dispute (Venturini 2010). This results in a visualization that is solid enough to be circulated. Despite acknowledging all the possible construction work involved in making a map (Latour 2005; Venturini 2010) CM still aims towards objective connections between the visualization and the world but objectivity is obtained through the presence of many objectors (Latour, 2005).

Figure 2, and the approach of CM, is in that sense a strange fit on the vertical axis, which it actually aims at overcoming. It is positioned in the middle because of its explicit commitment to creating full controversy maps that are nonetheless modes of seeing. On the horizontal axis it is positioned to the left because it is initiated from a trusted corpus of publicly available documents from official organizations, media sources, image galleries and videos portals. These documents are validated as being relevant to the controversy by a set of human coders. It is not the sources but their ability to demarcate a comprehensive set of relevant actors that is the basis for using them as starting points.

Towards the bottom-right corner
The approaches of ‘web-sphere analysis’ (WSA) and ‘cross-sphere analysis’ (CSA) each take steps towards the bottom-right corner of the typology. Instead of being driven by the question of whether traces on the web are valid representations of social networks or contribute to objective simulations of reality, these approaches attempt to learn about social dynamics by ‘following the web’ and the mode of seeing it provides (Rogers 2009). But despite being closely related, the two approaches exhibit important differences that positions CSA further down the bottom-right corner than WSA.

WSA aims at demarcating a set of web-resources that are relevant to a specific event or theme of interest (Schneider and Foot 2005). Despite being constructed before the concept of ‘web-spheres’ gained widespread popularity, Figure 4 serves as a good example of this approach. Its theme of interest is the debate about climate change and it depicts one step in the displacement of this debate from having the United Nations as the main addressee to being centred on the World Bank’s funding of fossil fuels (Marres, 2005). The visualization was made by following hyperlinks from organizational websites discussing an evaluation of the World Bank’s activities called the Extractive Industries Review (EIR). It depicts the ‘issue-network’ that was active in the displacement and illustrates how the involvement of NGOs, Nobel Laureates and Newspapers opened the issue for critical scrutiny on the web (and how it was subsequently closed again). By starting from relevant organizational websites and a specific report it belongs to the left side of the horizontal axis. But it is positioned a little more to the
right than the approaches above because the web is at the centre of data selection. The criterion of relevance is balanced by an interest in specific media that renders controversies public and traceable through a specific mode of organizing information. The visualization is purposely aligned with the ‘bias of the web’ because this bias allows the issue of climate change to be encountered in a reified state that is suitable for disclosing the attachments and associations of organizations involved in the ‘public-ization’ of the issue (Marres, 2005). From the perspective of the vertical axis we can say that WSA is interested in a specific sociotechnical mode of seeing controversies. But it retains representative ambitions in the sense that it ultimately understands a web-sphere as a singular phenomenon that can be more or less representatively uncovered by the researcher (Schneider and Foot 2005).

Figure 3 reflects this understanding in its ambition of disclosing the issue-network that are engaged in formatting the controversy about EIR on the web and thereby also the publics that are sparked into being by this issue.

CSA is closely related to WSA but it differs by comparing the way objects are given meaning in different spheres on the web rather than demarcating a full set of relevant digital resources or a full issue-network. One CSA study compares the way the object of a ‘sustainable home’ is given meaning in the blogosphere with the meaning attached to it in a larger web-sphere. It shows how the discussion in the blogosphere is centred on the home as a space for activity whereas the discussion on the web is centred on the fact that such homes are often new and purpose-built. CSA occupies a unique position on the horizontal axis because its starting points are determined by querying the information-filters that dominate the spheres of interest. The strategy is to ‘follow the filters’ rather than following relevant organizational web sites (Rogers 2009). The blogosphere is, for example, demarcated on the basis of

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**FIGURE 3** Visualization of the issue-network around the Extractive Industries Review (Marres 2005).
links from the search engine Technorarti. This filter comes to function as an ‘epistemology engine’ in the sense that its logic of organizing and ranking blog-content about sustainable homes is used as the ground for initiating the visualization (Marres et al. 2009). Whether or not Technorarti returns relevant and reliable web-sites is not the driving factor. Such a benchmark of relevance is not established before the practice of visualizing. CSA takes one step further down on the vertical axis because the ambition of representation is reduced from representing issue-networks on the web to representing meanings attached to objects in subspheres of the web.

A latent third dimension

The proposed function of the visualizations is the basis for a latent third dimension in the typology, which is signified in the form of unbroken and dotted boxes. The unbroken boxes contain visualizations that aim at providing their reader with a basis for taking action in relation to the technological development in question. In SNA and WA this action is thought of in terms of policy-making and technology management. Figure 2, for example, concludes with a suggestion to the producers of nanotechnology to engage in the debate and the visualization is meant as a help to indentify effective communication channels. The study of second generation biofuels similarly aims to provide early warnings about the potential disconnection between sectors in the field and it identifies technology platforms that can function as potential brokers to remedy this development.

CM is also oriented towards political action, albeit in a more democratic way than the managerial recommendations above. The London 2012 map is constructed as a democratic intervention that enables its readers to grasp the complexity of concerns around the stadium rather than feeding them with facts about it. The online version is interactive in the sense that it allows the user to rewind the composition of the map in time, to zoom in and out between different levels of aggregation and see details of the connection between the nodes (Yaneva 2012). Popularly speaking the MACOSPOL visualizations are meant to establish a form of ‘quasi-parliament’ that depicts the arena within which it would be fair to settle the controversy in question (Latour 2011).

The dotted boxes contain visualizations with less action-oriented ambitions. They are produced to allow the viewer to better grasp the way controversies are organized on the web and how this organization may indicate something about the social and cultural development around emerging technologies. Figure 4 provides insights into the ways in which processes of issue formation mediate public involvement in politics and the study of sustainable homes provides its reader with an understanding of the dynamics of mediation that shape the meaning of this object in different web-spheres. The visualizations of WVA and CSA shape the democratic sense of the reader in relation to the way information and knowledge is organized on the web and they use the logics of the web to learn about the role of issues in democratic politics. But their ambition is not to directly guide managerial and democratic action.

The discussion so far has allowed for positioning the reviewed projects on the typology as illustrated in Figure 4. Each of them has been introduced as an example of a general analytical approach that serves as the header of the
box in which they are mentioned. Figure 4 also contains a punctuated box with the word ‘web-vision analysis’, which denotes an analytical approach that is developed in the second part of the paper.

**A framework of ‘web-visions’**

This section will introduce ‘web-vision analysis’ (WVA) as an approach that builds upon different aspects of the reviewed approaches while at the same time suggesting distinct ways of constructing, interpreting and using visualizations. The first sub-section concerns the position of WVA on the horizontal axis. Taking its point of departure in the logic with which filters organize information on the web it has clear roots in CSA, it approaches these filters as devices that give rise to calculative spaces. It thereby leaves the concept of web-spheres in a way that has consequences for the way filters are used and interpreted as starting points. The second sub-section concerns the vertical axis and it explains how these filters are conceptualized as giving rise to ‘visions’ that structure the attention of its user. This theoretical move has roots in the part of CM that emphasizes the performativity of descriptions but it leaves the ambition of creating comprehensive visualizations of full controversies. The third sub-section argues for embracing the incomprehensiveness of the visualizations by treating them as cases. The suggestion to use case-study logic as the basis for empirical choices about starting points and software tools in the visualization process is unique for WVA. The three sub-sections explain the distinct position that WVA occupies in Figure 4. After that the subsequent section provides details about the actual construction of a series of web-visions in order to more concretely indicate how this approach can guide empirical visualization-projects.

**Information-filters as distributed calculative devices**

WVA follows CSA in using web-based information-filters as starting points of visualizations. But it approaches them as devices that give rise to calculative
spaces rather than web-spheres. In economic sociology such spaces are thought of as allowing actors to make distinctions between goods, decide on common operating principles for establishing relations between them and ultimately assign value to them (Callon and Muniesa 2005). Besides providing the conditions for valuating goods such spaces also include a mechanism that synthesizes acts of valuation into ‘orders of worth’ by organizing and raking their importance (Stark 2011).

There are strong parallels between the devices that constitute markets and the filters that are used as starting-points in WVA. The Google search engine is, for example, used as a starting point below and just as market devices assign prices to goods, the function of Google rankings is to assign visibility and relevance to information in response to specific queries. It creates a ‘market of relevance’ that depends on a calculative space similar to the one economic sociologists have detected in the market of goods. In order for this market of relevance to organize the debate about any given technology it needs information about it to be divided into clearly demarcated pieces of information expressed on web-pages with unique URLs and unique time-stamps. This process of ‘singularization’ mirrors the way distinctions are made between goods in economic markets and it makes each piece of information apt for receiving standardized markers of relevance, such as hyperlinks. It furthermore allows synthesizing mechanisms to generate a search results page that locates some information in the center of visibility while leaving other sources in the dark. Like a market of goods, it gives rise to a calculative space of associations where the web-user is ultimately ‘[...] dependent on lists of ratings and rankings to navigate the uncertainties of finding what’s valuable [...]’ (Stark, 2011). A further similarity to the construction of markets is that this space is assembled by human as well as non-human actors. On the human side we find web-masters forging hyperlinks and building websites as well as web-users following these links in specific patterns. The non-human side is dominated by the PageRank algorithm which is the backbone of Google. Both types of actors play a role in organizing the ‘market of relevance’ that draws boundaries around a given issue.

On the basis of these comparisons to markets of goods the starting points of WVA are conceptualized as ‘delineation devices’ and defined as follows.

A delineation device is an entry-point to the web that organizes digital traces left by a distributed set of actors in order to establish a space where information can be divided into detached digital objects to which values of relevance can be assigned.

Different delineation devices lead to different judgments of relevance because they take different acts of valuation into account. WVA is solely focused on the relationship between the calculative characteristics of such devices and the modes of seeing they create. It is strongly inspired by the way CSA approach act as ‘epistemology engines’ and the suggestion to compare the visibilities they offer, but WVA suggests that detailed analyses of the calculative characteristics of the filters should be a more explicit part of the basis on which they are selected. Technorarti may be an entrance to the blogosphere but so is Google Blog Search and the differences produced by the alternative calculative spaces is the centre of focus in WVA. This is different than focusing the way they serve as entries for a potential common sphere.
Web-visions as structures of attention

The outcome of a delineation device is the ‘web-vision’ of the person using it and it is defined as follows.

A ‘web-vision’ is the specific actors, themes and documents that become visible to a user when entering the web through a specific delineation device at a specific time.

This concept is in alignment with recent developments in economic sociology where the concept of ‘screened visions’ is used to denote a situation where some information is revealed to a trader looking for information about stocks on a computer while other pieces of information are screened away from her view. These visions are argued to be relational in the sense that ‘the very process of focusing on an object entails locating it in a field of other objects’ (Prato and Stark 2011). Such a relational screening is central to web-visions that also structure the attention of the reader.

WVA suggests operating with two distinct types of visions that can be illustrated by continuing the example of Google. If a user types ‘synthetic biology’ in the search box of Google it will return a list of URLs that are ranked according to specific criteria of relevance. This list of URLs is the most immediate way in which the device makes this controversy visible and it is therefore conceptualized as the ‘myopic vision’ it provides its user with. From this list of URLs the user can follow a selection of hyperlinks in order to explore the controversy further and through this exploration he or she will encounter a specific range of actors, themes and documents that form a specific narrative. This scope of extended visibility is denoted as the ‘hyperopic vision’ of the device.

Whereas the ‘myopic vision’ is largely an effect of the delineation device, the ‘hyperopic vision’ is just as much an effect of the way the researcher chooses to operationalize it. The search results page is given by Google but the visual depiction of the ‘hyperopic vision’ is tied to choices about the software that is set to crawl the hyperlinks. It is a performative description in the sense that is highlighted by Latour and WVA draws upon this way of thinking in emphasizing the need for a more explicit focus on the software choices behind visualizations than the reviewed approaches have. Approaches at the top of the vertical axis discuss such choices within the tradition of minimizing bias whereas WSA and CSA seems to suggest a tie between the settings of a crawler and the type of network it generates (Govcom no date). The choice between different default-setting in the crawler is motivated by pre-defined notions of network types in the sense that a specific setting is argued to return a ‘social network’ whereas another setting returns an ‘issue-network’. This way of connecting setting and types of networks seems in line with the idea that specific starting-points (such as Technorarti) are connected to specific spheres’. It is also in the discussions of software choices that CM exhibits its realist ambitions. In MACOSPOL we, for example see software tools presented as means for detecting the partisanship of stakeholders and assigning them a place in a controversy-map that fits their real position (MACOSPOL no date). WVA ultimately suggests tying software-choice to the desired mode of seeing in the way explained below.
Case-study logics as the heart of visualization

The steps above suggest moving the characteristics of delineation devices and software tools closer to the heart of the visualization strategy and the methodological consequence is to ground choices about them in the logic of case selection (Flyvbjerg 2004). Instead of thinking about them as tools for obtaining reliable representations, as tools for achieving second degree objectivity or as entry-points to pre-defined spheres and network-types, they are thought of as giving rise to web-visions with quite specific calculative characteristics. Web-visions are cases that result from deliberate combinations of devices and tools, and the mode of seeing that results from these combinations is the basis of their potential relevance. Specific combinations may, for example, produce visions that are 'least likely' or 'most likely' to make specific aspects of a technological development visible or visions that are 'paradigmatic' in the sense that they depict a common mode of seeing in relation to a specific technology (Flyvbjerg 2004).

An empirical example of how this methodological logic can be used will be given below but the central argument is that the researcher is left with an arsenal of variables that can be used to manipulate the construction of the web-visions in a quasi-experimental fashion. The mode of seeing can, for example, be tweaked by altering the logic of filtering in the delineation device, the country of origin of the device, the language used to query the device or the settings of the web-crawler used to construct the visualization. These variables are the a priori knowledge from which the visualization starts. The next section will outline the details behind the construction of concrete hyperopic visions in order to make clear how the approach differs from the reviewed approaches in the way it guides empirical choices and interpretation in relation to the practice of visualizing.

‘Web-visions’ of synthetic biology

The visualizations shown below are bits of a larger longitudinal study that follows web-visions of synthetic biology, which is the latest attempt to bio-engineer organisms with useful functions such as improved photosynthesis in plants. Since The Craig Venter Institute succeeded in producing a synthetic cell in May 2010 different actors, among which Barack Obama is one of the more prominent, have debated the benefits and drawbacks of synthetic biology. The process behind the construction of the web-vision highlights the centrality of delineation devices and software tools in the research design and illustrates how case-study logic can be utilized as a research strategy.

Delineation devices as starting points

When it comes to starting points we saw that many of the reviewed projects take their point of departure in relevant and reliable organizational websites. WVA delegates this choice to delineation devices and the web-visions in the longitudinal study are produced having Google.co.uk, Google.com, Wikipedia.com and Google.com/blogsearch as starting points. The reasons for choosing them were grounded in their case-related characteristics.
The first reason was their status as ‘paradigmatic cases’ of the kind of entry-points to the web that people use in the United Kingdom — a country in which public discussion of biotechnology has a strong history. Because these devices generate paradigmatic visions they make it possible to reveal the narratives and actors made visible to UK web-users. The choice of starting points was based on data about web-usage in the UK on Alexa.com and they were queried for the term ‘synthetic biology’ because Google Insights, Blog Pulse and Wikipedia proved this search-term to be more frequently used than similar terms such as ‘synthetic life’ or ‘constructive biology’.

The second reason for choosing them was that each of them has calculative characteristics that make them ‘most likely’ or ‘least likely’ cases in relation to a specific research interest in the geography and fluidity of the controversy. The visions produced through google.co.uk are, for example, ‘most likely’ to make British actors and themes visible in comparison with the other visions. If such actors are not visible in the google.co.uk visions one may suspect that they are not visible in the other visions either. The visions produced through wikipedia.com are, in a similar fashion, ‘least likely’ to change rapidly from month to month compared to the other visions because its consensus-based filtering makes it a less fluid calculative space. Fluidity would therefore be an indication of a highly active controversy.

After deciding on delineation devices and search terms the ‘myopic visions’ were operationalized. In Google and Google Blog Search they were taken to be the top 20 URLs returned in the search result page after depersonalizing the search and in Wikipedia it was taken to be the URLs listed in the ‘external links section’. Despite looking rather simple the process of creating a myopic vision, involves choices about case selection, search terms and depersonalization that delegate narrative power to a range of software tools. This serves to show that a researcher can ‘follow the medium’ in many ways and even though these choices ensure that the web-visions have the desired case-characteristics, it is not ensured that they are representative pictures of the discussion about synthetic biology in the UK, on the web at large nor in a web-sphere connected to a specific device. The visions are also far from being comprehensive maps of the controversy. They are only interesting because these choices allow for structured comparisons of visions based on prior knowledge about the case characteristics of the delineation devices.

**Software tools and the construction of modes of seeing**

The hyperopic visions were constructed by crawling the web from the URLs in the myopic visions and the next crucial decision was therefore to decide how to set the parameters of the software tool when carrying out this crawl. The visions were produced using the Issue Crawler and their construction began by enforcing a structural and a semantic criterion (Marres and Rogers 2005). According to the structural criterion a URL could only belong to the hyperopic vision if it received more than one link from the other URLs in the vision and the crawler was therefore programmed to conduct a co-link analysis that discards all URLs receiving less than two in-links. According to the thematic criterion a URL could only belong to the hyperopic vision if it actually mentioned the issue of synthetic biology. All the URLs that fell
within the boundary of the structural criteria but did not mention synthetic biology were therefore taken out of the visualization.

The application of these criteria determined which URLs became visible in the visions. The next choice was how the hyperlink-networks returned from the crawler should be shaped, coloured and cleaned. It was decided to shape the visualization through a spring based algorithm that measures distances between nodes and to colour it manually on the basis of categories such as ‘geography’ and ‘organizational types’ deemed relevant by the researcher. It was finally decided to ‘clean’ the visualizations by removing elements that the crawler had ‘wrongly’ put in there. For example there was an enormous number of ties to Creative Commons because most web-sites use their license to publish text in a way that is completely unrelated to the controversy about synthetic biology.

These choices have huge impacts on the shape of the visualizations and they inevitably create a specific mode of seeing that guide the attention structure of the person reading the map. By only retaining sites that receive in-links from at least two seed-sites and mention synthetic biology, the structural and semantic criteria narrowed the scope of the hyperopic vision. The networks presented as ‘hyperopic visions’ are accordingly to be understood as a mode of seeing that reflects the most well-connected URLs in the vision. The main methodological reason for composing the visualizations in this way was, once again, that this narrowing had the consequence of making the visions ‘less likely’ to be different to each other when compared across delineation device and time-slot. Using software choices to make the visualizations as similar as possible allow for more solid interpretations of the differences that become visible despite this choice. The choices cannot be defended in terms of representing full controversies, specific types of networks or specific web-spheres.

**Interpreting web-visions**

The web-visions in Figure 5 are three examples from the longitudinal study and even through their visual surface is similar to the reviewed visualizations it has been explained how the strategy behind their construction is different. They are produced by following google.co.uk in January, April and June 2011 through the steps described above. The discussion below will illustrate how web-visions must be interpreted in a way that is tightly coupled to the choices made in the construction process. It will, however, only comment briefly on the characteristics of the visualizations and it will not go into a full qualitative analysis of the assemblages created around synthetic biology. In a full empirical analysis this would be necessary but it is not mandatory for understanding the logic of the methodological approach.

Of all the ‘paradigmatic cases’ followed it was argued that google.co.uk is the calculative space that is ‘most likely’ to make UK actors and themes visible. The nodes were therefore shaped according to their geographical origin in order to make it possible to focus the attention of the reader on this aspect. When doing that it becomes clear that the visibility of UK-based web-sites (square nodes) is highly fluid across the three timeslots. From
January to June the percentage of UK-based sites in the visions dropped from 39.5 to 13.5 per cent whereas the percentage of US-based sites rose from 33.5 to 66 per cent. These numbers represent a process in which a tight cluster dominated by UK-based funding agencies such as BBSRC, EPSRC, The Wellcome Trust and MCR slowly disperses. The circles in Figure 5 highlight this development and the circles highlights how a cluster of US-based governmental actors, led by The National Center for Biotechnological Information, gains visibility instead.

Accompanying this shift we can also detect a shift in the visibility of actors that belong to the category of ‘Policy advice, social science or public engagement’. Their share of the overall vision rose from 8 per cent in January to 15 per cent in June, but a closer inspection reveals how this rise covers an institutionalization that makes British actors in this category less visible as well. In both January and April we can see that UK-based designers and artists such as Daisy Ginsberg and James King are central in posing social and ethical questions through their project called ‘synthetic aesthetics’. In August they are, however, substituted by actors such as The Hastings Center and the ETC group that have a history of working with social aspects of biotechnology in North America. The darker circles in Figure 5 highlight this shift.

The development has the consequence that the visions of Google.co.uk increasingly become similar to the wikipedia-visions from January to June (these are not shown, however). As expected the wikipedia-visions are quite stable throughout the period. US actors already make up 66 per cent of the vision in January and the The Hastings Center and the ETC Group are visible actors throughout the whole period. The reason for the increasing similarity between the visions generated from the two delineation devices may be that Barack Obama requested The Presidential Commission for the Study of Bioethical Issues to make a report about synthetic biology that was published in December 2010. The web-sites that make up the US governmental cluster that we saw gain visibility in June version of the Google.co.uk vision are all mentioned in this report. An effect of their visibility, as well as the institutionalization of the social actors, is that The Craig Venter Institute occupies a far more central role in June than in January (marked in circles in the January and June visions in Figure 5).

**Figure 5** Web-visions of synthetic biology produced by the author in (a) January 2011, (b) April 2011 and (c) June 2011. A larger version of the visualizations and details about the colouring of nodes can be provided by the author.
If this interpretation is correct it serves to show that action on the part of big institutionalized American actors have the potential to shape the calculative space generated by Google.co.uk quite drastically. A complementary study of a Google-vision with a different language than English could reveal the extent to which this influence is due to shared semantics. Stability in the German version of Google during the same timeslot would, for example, indicate that the public visions of UK users are influenced by the fact that the British and American language is semantically similar. Such differences would be even more striking if the structural and semantic criteria are enforced because they make the visions less likely to be different.

These insights are tightly coupled to case-study logics and in relation to the latent third dimension they seem to position WVA as being less action oriented than SNA, WA and CM. They are reflections on calculative media-spaces. But the research strategy may also enable the WVA to inform political and managerial action in a way that has nothing to do with representation or second degree objectivity. Taking the visions of Wikipedia we have, for example, seen that they are very stable over time and continually includes a quite institutionalized set of actors. This is a consequence of the fact that the calculative space of Wikipedia is built around consensus. Since the visions based on Wikipedia are ‘least likely’ to be fluid it will be a good proxy of a dynamic controversy if the Wikipedia-vision were suddenly very fluid. Such insights could guide a useful monitoring of technological development that is quite different to the approaches reviewed earlier.

Conclusion

This paper started by reviewing influential analytical approaches to constructing web-based visualizations of social dynamics surrounding emerging technologies. It provided a three-dimensional typology along which these approaches were positioned according to the data from which they initiated the visualizations, the ontological status they ascribed to them and their proposed function. On the basis of this review the paper developed the framework of WVA (Web-based Visions Analysis). It was emphasized how it draws on the organization of information emphasized by CSA (Cross-Sphere Analysis) and on the part of CM (Controversy Mapping) that emphasizes the performativity of descriptions. The concepts of ‘delineation devices’, ‘calculative spaces’, ‘myopic visions’ and ‘hyperopic visions’ were, however, introduced in order to position WVA as a distinctive approach that conceptualizes visualizations as sociotechnical modes of seeing that are tightly connected to choices about starting points and software in the construction process. WVA was argued to most distinctively differ from the reviewed approaches in suggesting to use case study logics as the basis for making empirical choices in process of constructing and interpreting visualizations.

The details of the construction of three web-visions of synthetic biology were then outlined. Based on google.co.uk as the starting point they illustrated how case study logic can be utilized in a concrete research design. The visions were constructed because they illustrate a specific calculative
space that is used by many people in the UK, which have a specific tradition of public discussion of biotechnology. Google.co.uk was furthermore followed because it is the ‘most likely’ of the delineation devices used in the UK to resist the American influence described. Its changing shape from January to August 2011 accordingly provides insight into how the potential attention-structures of British web-users are changing over time. Besides generating such media-specific insights it was also argued that knowledge about the characteristics of calculative spaces have the potential to inform political and managerial action in a way that has nothing to do with representation or second degree objectivity. Existence of fluidity in the Wikipedia-vision was, for example, argued to be a good proxy for detecting active controversies because it would normally change slowly due to its consensus orientation. Based on the review, the theoretical discussion and the empirical insights it was argued that WVA offers additional and different analytical strategies for constructing and interpreting web-based visualizations of emerging technologies.

Note
1 http://www.issuecrawler.net/

Bibliography


Notes on contributor

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