Knowledge infrastructures: Part I

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The focus of this special issue is on Knowledge Infrastructures. We have witnessed important changes in research and knowledge production in recent decades associated with developments in information technologies and infrastructures. In some circles these changes are promoted as a transformative force enabling new forms of investigation, but they may also be perceived as buttressing existing forms of research. These developments aim to pull people together, supporting distributed collaboration or facilitating new joint activities and endeavors across domains, fields, institutions, and geographies. They potentially offer new opportunities for the sharing and connecting of information and resources–data, code, publications, computing power, laboratories, instruments, and major equipment. They often bring together a diversity of actors, organizations, and perspectives from, for instance, academia, industry, business, and general public. The social, material, technical, and political relations of research and knowledge production appear to be changing through digitalization of data, communication and collaboration, virtualization of research communities and networks, and infrastructuring of underlying systems, structures, and services. These emerging phenomena participate in ongoing transitions in the scholarly arena, and in society in general: traditional ways of doing research may be challenged and knowledge production may become more distributed and broader in participation. These phenomena have been cast under several labels such as big science, data-driven science, networked science, open science, Digital Humanities, and science 2.0. Other terms used are: e-Science, e-Social Science, e-Research, e-Infrastructure, and cyberinfrastructure.

The stimulus for this special issue was a common realization that the time has come to draw together the current state of developments in this topic area as viewed from the perspective of Science and Technology Studies (STS) and to evaluate the contribution of the distinctive set of theoretical resources of STS to the understanding of knowledge infrastructures. In doing so we build upon a considerable momentum of work in STS and related fields focused on the study of new infrastructures for knowledge production. The precursors of the current special issue include, for instance special issues in the *Journal of Computer-Mediated Communication* ('Exploring e-Science', Jankowski, 2007), *Journal of the Association for Information Systems* ('e-Infrastructure', Edwards et al., 2009; 'Innovation in Information Infrastructures', Monteiro et al., 2014), *Computer Supported Collaborative Work: The Journal of Collaborative Computing and Work Practices* ('Collaboration in e-Research', Jirotka et al., 2006; 'Sociotechnical Studies of Cyberinfrastructure and e-Research', Ribes & Lee, 2010) and the *Cultural Anthropology* journal ('The Infrastructure Toolbox', Appel et al., 2015).[1] Several workshops, conference sessions and theme-specific conferences have been held since. Edited collections on the topic include, among others, Hine (2006), Olson et al. (2008), Jankowski (2009), Dutton & Jeffreys (2010), Edwards et al. (2013), Wouters et al. (2013), and Mongili & Pellegrino (2014). Knowledge infrastructures have clearly piqued the interest of many scholars working in and around the STS tradition. The potential of knowledge infrastructures to unite a concern with the emergence of complex socio-technical systems with the enduring Sociology of Scientific Knowledge (SSK) interest in the micro-level practices and contingent outcomes of knowledge production makes them an attractive object for STS study. This interest is further stimulated by the emergence of knowledge infrastructures as a prominent topical field invested with significant cultural expectations, the focus of high profile investment from research funding bodies and government institutions.

Our aim in presenting this special issue on the topic of knowledge infrastructures is to take stock of existing research and chart new directions. For taking stock, the scope defined in the initial call for papers was deliberately inclusive. As an interdisciplinary research field, STS builds on a variety of disciplines and disciplinary subfields. Within the topic of knowledge infrastructures, several research perspectives are brought together. Interdisciplinary research integrations are often needed in order to engage with the complex technical, epistemological, and institutional aspects of these projects, and the cross-fertilization is broadening beyond the founding STS disciplinary field to include, for example, Social Informatics, Library Studies and Information Sciences. Also, while most of the existing work has focused on studying knowledge infrastructures in the natural, medical, and engineering sciences, studies of knowledge infrastructures in arts, social sciences, and humanities are on the rise, thus increasing the variety of domain-specific (sub) disciplines. In the call for papers we therefore did not restrict the domain of knowledge and, indeed, hoped to bring together papers that explored the development of infrastructures across a wide range of institutional settings and both within and beyond academic science. The resulting crop of papers has indeed realised this aspiration: in this issue we present papers relating to industrial environmental monitoring, public health surveillance, and Wikipedia's portrayal of schizophrenia. Future issues will expand the institutional focus again and also explore scientific and social scientific knowledge production. The juxtaposition will, we hope, enable an evaluation of cross-cutting themes and fruitful cross-fertilization of ideas across domains of knowledge that might otherwise be kept separate.

Taking stock and charting new directions in knowledge infrastructures research appears all the more necessary as the complexity of the phenomena calls for theoretical and methodological developments, actively engaging STS scholars to revisit existing approaches and contributions. The issues not only relate to how we can best study and understand knowledge infrastructures, but also how we could imagine them moving forward (Edwards et al., 2013) and to what extent we expect STS scholars to be an active part of imagining these futures.

In STS the study of infrastructures has roots in the history of Large Technical Systems: initially focusing on electricity supply networks (Hughes, 1983, 1989) subsequently exploring other large systems such as transportation, water supply, district heating, and waste management (Van der Vleuten, 2004). The seminal work of Star and Ruhleder (1994, 1996), studying an early infrastructure for scientific collaboration, provided a first conceptualization of infrastructure as a contextualized 'relation' rather than a 'thing' and emphasized the situated practical work of developing and using infrastructures. During the following two decades, the early studies and concepts became widely used to inform new infrastructure studies and developments in a variety of contexts (Edwards et al., 2007). Theoretical challenges for studying knowledge infrastructures include understanding of the complex multi-scale relations and multiple scopes involved, the local and situated dimension of infrastructure together with its global and pervasive nature, and the complex work of alignment and coordination of activities across different socio-material worlds and technological arrangements. These dimensions have been and continue to be the focus of many studies, providing interesting approaches, perspectives, and metaphors. Yet, important aspects and areas remain under-studied or under-understood. What are the main theoretical contributions of research on knowledge infrastructures in past decades? How could STS and other fields' perspectives, concepts and metaphors be revisited and advanced? Some tentative answers will be drawn out at the end of this editorial, but this key set of questions will be revisited in future issues as the corpus of papers builds.

Methodological challenges related to the study of knowledge infrastructures include their geographical distribution across multiple locations and within online spaces, their evolution over extended periods of time, their sociotechnical nature, the multiplicity and heterogeneity of participants and institutions involved as well as the 'double challenge' of having to understand both information technologies and the domain discipline(s) under investigation. Methodological developments so far have provided tools and orientations for studying the mundane and the invisible (Star, 1999), such as the 'infrastructural inversion' suggested by Bowker (1994) to focus on all the activities that warrant the functioning of infrastructure (e.g. formation, maintenance, upgrade, breakdown, repair) rather than those that it invisibly supports. New ways to study large or distributed phenomena – offline and online, as well as longitudinal, multi-sited, multi-scope, and 'messy' dimensions of infrastructures are suggested (Hine, 2000, 2008; Beaulieu, 2010; Karasti et al., 2010; Jackson & Buyuktur, 2014). As STS scholars have a history of 'intervening' while studying science and technology phenomena, approaches have been developed to not only analyse the outcomes of knowledge infrastructure work but also to engage actively with the formation, enactment, and co-construction of infrastructures (Neumann & Star, 1996; Ribes & Baker, 2007). As we issued the call for papers for this special issue, we were interested to examine what kinds of innovative methodological developments would emerge. How could existing methods be improved? What roles are STS scholars adopting in relation to the projects they study, and is an active or embedded STS emerging in this field? Again, this editorial introduction makes a first pass at identifying methodological approaches that prove promising, but this will be revisited in future issues.

Articles in this first part of the special issue

The three articles presented in this first part of the special issue provide some elements to frame our initial evaluation of emerging themes. We briefly review and reflect on the articles, whilst also pointing to the way they contribute to furthering our understanding of infrastructures for knowledge production. The following section then draws together emerging theoretical and methodological developments and evaluates their contribution to the existing literature.

The special issue opens with an article by Sally Wyatt, Anna Harris, and Susan E. Kelly focusing on a knowledge infrastructure that sits outside of scholarly knowledge production, narrowly defined. Wikipedia's infrastructure allows a diverse set of actors including scientists and lay people

to participate in the production of a publicly available knowledge resource that aspires to be neutral and evidence-based. Wyatt et al.'s exploration of the processes that lead to the production of this knowledge resource suggests that rather than simply reflecting existing knowledge, the Wikipedia infrastructure offers a site of active knowledge production, through the work that goes into curation of resources, which in turn involves ongoing interpretation of Wikipedia's own rules for participation.

The article "Controversy goes online: schizophrenia genetics on Wikipedia" utilises a specific aspect of the Wikipedia infrastructure as a methodological tool. In order to explore the active practices underpinning the production of two key, and often controversial, Wikipedia entries focused on schizophrenia, the authors analyse the content of the Talk pages that track the editing of the page and record discussions between editors about appropriate edits to make. By focusing on the Talk pages relating to schizophrenia genetics Wyatt et al. are able to explore the interpretive work that lies behind decisions on what should be included in the page and on the weight to be given to the various positions within this highly controversial field of research. Editorial work is carried on with reference to over-arching rules for participation within Wikipedia, which require, for example, use of reliable published sources, prohibit original research, and dictate use of a neutral point-of-view. The Talk pages demonstrate a strong prioritisation of published scientific literature and also reliance upon published reviews to avoid having to curate lists of single studies and thus risking accusations of drawing original conclusions. However, the actual choice of points to include in the entries on schizophrenia is shaped in practice by a somewhat ad hoc interpretation of what counts as a credible study or an appropriate high-level review, by an embedded hierarchy among the editors and by differential expertise and access to resources across those editors.

Taken at first sight the infrastructure of Wikipedia, including the rules for participation, appears to act to discourage the emergence of controversy, but through the Talk pages Wikipedia preserves traces of the work through which this smoothing over of controversy is achieved. Wyatt et al. note that the production of the schizophrenia pages relies upon an active process of citation and curation that is at times contradictory and not always apparently in compliance with the overt rules of Wikipedia. Contrary to observations from previous STS studies of infrastructure that the work that sustains an infrastructure is often rendered invisible, the authors argue that Wikipedia provides an interesting case in which the infrastructure itself makes visible the work that goes into sustaining it. In particular, they suggest, Wikipedia and the internet more broadly offer STS a new array of sites to allow study of controversies in action.

The second article "A measure of 'environmental happiness': Infrastructuring environmental risk in offshore oil and gas operations" by Elena Parmiggiani and Eric Monteiro reports on the development of a knowledge production process and knowledge infrastructure to introduce environmental risk monitoring into an industrial setting. The oil and gas company in question wishes to establish a baseline for subsea environmental monitoring in response to the Norwegian government's promotion of knowledge-based approaches for decision-making affecting the environment. The company's selected site for performing real-time environmental monitoring is a sub-Arctic marine ecosystem off the coast of northern Norway. The area is estimated to be rich in petroleum resources but currently banned for drilling. Establishing a knowledge infrastructure for real-time environmental monitoring is seen to position the company favourably in the case of future opening of the High North for oil and gas operations. However, these inhospitable (to human) sub-sea areas are also ecologically rich in flora and fauna, providing habitats, for example, for the world's largest population of a species of cold-water coral and the world's largest stocks of fish, and the scenic coastline is attractive for tourism and recreation. Constant controversy prevails between environmental concerns, fishing industries and oil and gas operations.

Parmiggiani and Monteiro's article investigates the integration of a new type of activity, environmental monitoring, into the company's existing safety and risk assessment infrastructure as "an effort of innovation and experimentation at the

fringes between operation-based monitoring and long-term environmental monitoring". The paper focuses on the data construction process across a knowledge-infrastructure-in-the-making with a specific interest in how uncertainty about the marine environment is quantified into a knowledge base. Three infrastructuring mechanisms are identified, i.e. sensoring, validating, and abstracting, to participate in the 'cooking' of the 'raw' data into a new "measure of environmental happiness". The little knowledge available of a small sub-marine location is quantified into representations of ecosystem behavior and embedded into the operations of a global oil and gas company. All this necessitates a knowledge infrastructure, the analysis of which needs to be able to account for the networked and long-term dynamic relations between social, technical, and natural elements.

Parmiggiani and Monteiro further our understanding of infrastructures for knowledge production by discussing how the emerging spatial, temporal, and socio-political tensions are leveraged in practice in the process of infrastructuring the sub-marine ecosystem into a baseline across the knowledge infrastructure. First, spatial tensions arise in the full range from data collection and interpretation to risk representations. A fishermen's echo sounder is repurposed for environmental monitoring, but as the sensor's location and (im)mobility as well as spatial perspective are altered, the 'same' data acquired with the 'same' instrument are rendered quite different for interpretation. Through risk representations, such as the coral risk matrix, environmental value indicators are made global but remain grounded in the historical data collected at the local site. Second, the real-time and long-term temporalities inherent to environmental monitoring pose new concerns. Environmental monitoring has become fast, interconnected, and open to close scrutiny. The different conceptions of time are frozen into different enactments of risk, such as the company's bonus/penalty contract and risk matrix, including understandings of compromises and trade-offs between the temporalities of risk to different participants (nature, partners, and oil and gas industry). Last, NorthOil, having a strong but contested political-economic position in the Norwegian context, has constructed its infrastructural activities in the sub-Arctic as a public problem for specific audiences. The infrastructuring mechanisms are complemented by continuous application of strategies, such as social networking and openness with regard to risk representations. These measures are directed at building trust (rather than consensus) because while the means of environmental monitoring can be shared the ends are seen differently by fishermen, research institutions, and the general public.

The final article of this first part of the special issue, by Angie M. Boyce, reports on public health surveillance activities in the US and the repurposing of materials and data in connecting heterogeneous infrastructures. Public health surveillance activities depend heavily on infrastructures built for other purposes to achieve their goals (they are 'second-order systems'); materials, data and information from the health care and food systems need to be connected to identify the ultimate cause of an outbreak. The paper presents an ethnographic analysis of a case of foodborne outbreak detection to analyze the practical work of repurposing materials and data from other sources and address the 'frictions' that arise between the systems and infrastructures.

The article "Outbreaks and the management of 'second-order friction'" addresses two important aspects of infrastructural interdependency: the practical work of creating and maintaining dependent systems and the broader sociopolitical and ethical consequences of interconnecting infrastructures. Public health surveillance implies piecing together and reworking materials and data created by diverse actors in different contexts. The role of the health care system is to treat patients, and in order to do so to collect information relevant to fulfilling its clinical function, while public health surveillance implies collecting, analyzing and interpreting health data in a systematic way, as well as integrating them into programs for prevention and control. The paper shows how connecting these heterogeneous sociotechnical infrastructures goes on through a daily work of 'repurposing' activities (for instance when a database managed by a national laboratory is being repurposed into a local

laboratory-epidemiology communication tool). The paper also shows that collegiality matters immensely for smoothing the frictions arising in such critical contexts, in which important information is generated at different times by different players. If databases serve as key tools, the human dimension of infrastructure (Lee et al., 2006) is also of particular importance.

Boyce introduces analytic language for understanding *multi-infrastructural dynamics*, by making use of notions such as 'repurposing' and 'friction' to surface the 'invisible work' (Star, 1999) of making infrastructures built for other purposes to serve public health needs. If these notions have proved to be helpful tools to study understudied dimensions such as infrastructure maintenance and repair (Jackson, 2014), her study shows in great details how they also help in understanding the nature of the dependent relationship between 'first-order' and 'second-order' infrastructures, together with the challenges entailed. The notion of 'second-order frictions' is suggested to talk about how the actors "enact and experience" the dynamic relationships between the different infrastructures involved in repurposing activities. They encounter frictions of many forms, such as 'moral' frictions associated with using shopper card data to assist in outbreak investigations (as a mean to address limitations of 'food histories' data collected through interviews with affected individuals), or concerns over data interoperability (when culture-independent rapid tests are preferred over culture-based methods in the health care system). The interconnection of multiple and heterogeneous infrastructures often implies broader sociopolitical and ethical consequences, and public health surveillance infrastructures provide good illustrations in this respect. Public health surveillance infrastructures become visible only when an outbreak occurs–connections between the public health and the food systems are made only in the context of outbreaks, on an ad-hoc basis. The invisibility of these infrastructures may definitively contribute to their neglect and potentially thus influence the health of the population.

Reflections on emerging knowledge infrastructure themes

The three articles presented in this special issue investigate knowledge infrastructures as diverse as Wikipedia, an environmental monitoring system in industrial settings, and public health surveillance infrastructures. They all present new ways of creating, generating, sharing, and disputing knowledge and explore the altered mechanics of knowledge production and circulation. The studies contribute to our understanding of infrastructures for knowledge production in different ways, each of them shedding new light on certain dimensions of knowledge and of infrastructure and contributing new threads to the STS interest in this field. In this section we draw out a preliminary set of cross-cutting theoretical themes and significant methodological issues.

With the notion of infrastructure comes the crucial question of scale: an issue rendered even more complex in this field as by their nature knowledge infrastructures are often accrued/layered and dispersed rather than discrete identifiable objects (both to those studying them and to those involved in their development and use). Knowledge infrastructures are seldom built *de novo* (Star & Ruhleder, 1994, 1996), they gather and accrete incrementally and slowly, over time (Anand, 2015). They are brought into being on top of existing infrastructures that both constrain and enable their form (Star, 1999). Knowledge infrastructures are ecologies consisting of numerous systems, each with unique origins and goals, which are made to interoperate by means of standards, socket layers, social practices, norms, and individual behaviors that smooth out the connections among them. The adaptive process is continuous, as elements change and new ones are introduced–but it is not necessarily always successful (Edwards et al., 2013: 5). While knowledge infrastructures may connect and coincide, they seldom fully cohere (Anand, 2015). Given the accrued/layered nature of infrastructure, navigating among different scales–whether of time and space, of human collectives, or of data–represents a critical challenge for both the design, use and maintenance of knowledge infrastructures (Edwards et al., 2013: 8) as well as for their investigation. The knowledge infra-

structures under study in the three papers here are large-scale infrastructures. They share typical infrastructural qualities, e.g. involving numerous entities, reaching beyond one-site practice, and implicating copious stakeholders. They span multiple information environments, technologies, organizations, regulatory frameworks, and so on. It is important, then, to note how the researchers have carved out the knowledge infrastructure for their investigation as this entails decisions as to which aspects of the infrastructure are included and which parts are ignored. It is important to recognize that "infrastructures operate on differing levels simultaneously, generating multiple forms of address and that any particular set of intellectual questions will have to select which of these levels to examine" (Larkin, 2013: 330). Study of knowledge infrastructures is often a process of identifying possible connections and potentially relevant contextualizing factors in tentative fashion, pursuing those connections that enable particular practices and decisions to make sense. The three papers presented here exemplify a careful approach to the emergent boundaries of the study but ultimately make contingent and potentially consequential choices on the specific focus of attention, shaped partly by the agency of the field in rendering some connections more possible to follow up than others.

Invisibility is a fundamental notion in infrastructure studies (Star & Ruhleder, 1996; Neumann & Star, 1996; Star, 1999, 2002; Bowker & Star, 1999; Bowker et al., 2010). The issue of invisibility resonates through the articles as an important analytical key to understand knowledge infrastructures. In this context, invisibility may refer to the invisible nature of the infrastructures themselves (Star & Ruhleder, 1996), the invisible work performed by actors (Shapin, 1989), and the processes of making visible–or invisible–activities and related challenges (Bowker et al., 1995). If the latter two have been much to the fore in studies on infrastructures, the invisible nature of infrastructures themselves has rarely been put into question. Indeed, we often consider infrastructures as invisible entities almost by definition, disappearing into the background along with the work and the workers that create or maintain them. Thus, infrastructures are often analysed in the making, in case of breakdown (Bowker et al., 2010) or observed as they are being formed, used, maintained, or repaired (Star & Bowker, 2002; Karasti et al., 2010; Jackson, 2014) since these moments make visible parts and aspects otherwise hard to uncover.

While invisibility is thus a recurrent theme in STS-influenced studies of infrastructure, experience has shown that some knowledge infrastructures are more amenable than others to study and that they do not all share the same degree of invisibility. This differentiation is seen across the three articles presented here. In Parmiggiani and Monteiro's study, the researchers realised that the workers involved in developing the new environmental monitoring knowledge infrastructure for the company, in fact, sought to answer the same questions as the researchers; they were engaged in making visible many hidden infrastructural issues, both existing and new, relating for instance to data, the sub-sea environment, and the instruments. The public health surveillance infrastructures studied by Boyce, in turn, may be envisioned as typical invisible infrastructures; they take shape at specific moments in time (in case of an outbreak) and even then, they do not present themselves as well delimited and easy to grasp entities but rather as complex and messy assemblage of systems, organisations, and people. An infrastructure like Wikipedia as studied by Wyatt et al. provides a set of online spaces that enable the practices behind curation work to become visible (the 'talk pages'), thus allowing the observation of the controversies in action. In this particular case, it is a specific property of the Wikipedia infrastructure that becomes a methodological tool for studying some otherwise less visible activities of knowledge production. Looking across these three cases, then, the classic concern of STS infrastructure studies with invisibility appears, but this invisibility plays quite different roles in the narrative of the articles and in the trajectory of the projects they study. In studying new infrastructures for knowledge production in quite different fields of deployment it is clear that we need to be sensitive to the varying orientations of the actors involved and those studying their work to the various degrees of silence and openness that this work entails.

The three articles share an STS perspective that does not expect sociotechnical work to proceed smoothly and is not only interested in the ultimate 'winners' but pays careful attention to the emergence of tensions, frictions, and controversies when studying these infrastructures and understands that the particular sets of relations that emerge through the development of an infrastructure could always have been otherwise. Where the infrastructure in question is a repository of knowledge, the way in which these tensions, frictions and controversies are identified (or ignored) and handled by participants is potentially highly consequential in shaping the resulting knowledge. The papers presented here exemplify the STS-inflected concern with questioning how a knowledge infrastructure emerges, who contributes to its fabrication, how it is made sustainable, and what are the wider political challenges associated with its development.

Because knowledge infrastructures always embody some kind of political agenda, because they 'grow' on a pre-existing installed base– 'piggybacking' on other infrastructures–they pose multiple sources of friction, conflict, or resistance activities. Aligned with the issues of tensions, frictions, and controversies, the articles presented here identify and discuss infrastructural activities that also speak to the dynamic, evolving nature of the knowledge infrastructure: enacting; infrastructuring through diverse forms of work including technology development, data generation, processing, and circulation, building trust with participants and potential users, and operating effectively on the socio-political level; and repurposing. Inherent in much of this work is the management of ambiguity and uncertainty and the development of specific relations of accountability to decide who makes determinations of whether a particular knowledge infrastructure or dataset is "good enough" for purpose. Of particular importance for the study of the knowledge infrastructures presented here are the processes by which pieces of knowledge are produced, circulated, repurposed, boxed, contested, or validated. This may imply looking at, among other things, how 'raw' data become 'cooked' to produce information, how a standard is enacted, in what ways a system gets repurposed, or how new representations are constructed to quantify risks for the environment.

If scale, invisibility, tensions, uncertainty, and accountability are among the interesting features of knowledge infrastructures, then how does this imply that we should study knowledge infrastructures? While infrastructures are often conceived of as large-scale entities, a common entry point for studying them is a level of analysis at a smaller scale. The methods used in two of the three articles (Boyce; Parmiggiani & Monteiro) are ethnographically inspired, whereas Wyatt et al. employ thematic analysis on the corpus of data collected from Wikipedia. Wyatt et al. neatly bound their empirical research object by collating all material related to two English-language schizophrenia genetics Wikipedia articles. They analyse the citation and curation of ambiguous scientific knowledge by examining 'infrastructural details' of internet technology, i.e. text, images, hyperlinks, and 'talk pages' that make visible the social actions of negotiating, producing, and circulating new forms of knowledge that is potentially global in its distribution.

The two ethnographically inspired articles engage in the 'infrastructural inversion', that allows researchers to scrutinize infrastructural "technologies and arrangements that, by design and habit, tend to fade into the woodwork" (Bowker & Star, 1999: 34). Their operationalisations of infrastructural inversion are, however, quite different. Boyce tacked "back and forth between the practical work of maintaining second-order systems, and the socio-political and ethical consequences of that work as a form of 'infrastructural inversion'" in order to better appreciate the "depths of interdependence of technical networks and standards on the one hand and the real work of politics and knowledge production on the other" (Bowker & Star, 1999: 34). She looked at the 'frictions' created by the interconnection of disparate infrastructures, finding that these frictions take many forms and are of different orders, ranging from technical incompatibility to moral concerns (e.g. repurposing shopper card information into data for food outbreak investigation). Parmiggiani and Monteiro, after realizing that the company employees were engaged in activities of infrastructural inversion as part of their work of devel-

oping the environmental monitoring knowledge infrastructure, followed the key actors in the field in order to learn with them. Based on this they were able to bring to the forefront also wider socio-political issues associated with knowledge infrastructures, focusing on, for instance, the ways in which a 'private' infrastructure of an enterprise became constructed as a public concern. In both of these studies the operation of infrastructures at multiple levels simultaneously, as outlined by Larkin (2013), becomes a live issue for the researcher to handle as they decide which aspects to examine and how, practically speaking, to bound their object of analysis.

Ensuing parts of the special issue

The initial call for papers on knowledge infrastructures received a good response, and has produced more papers than will fit in a single issue of the journal. Thus, the special issue will consist of several parts that will all appear in the course of year 2016 as papers complete the review process. In the special issue call for papers we solicited studies of knowledge infrastructures not limited to scholarly knowledge production, but addressing also, for instance citizen/civil science, as well as studies that address emerging forms of knowledge production, such as open data/science, or studies that explore knowledge infrastructures in commercial or public services domains. This request was generously responded to, as the articles in this first part of the special issue testify. The following parts will continue portraying the diversity of knowledge infrastructures both within and outside the academy, featuring also some more geographical breadth by including articles also from researchers outside Europe and the US. In future editorial introductions we will develop the analysis of emergent theoretical and methodological themes, in particular discussing further significant knowledge infrastructure themes, such as temporality and accountability, as they arise in the articles. In the editorial for the last part of the special issue we will focus particularly on charting new directions for the study of knowledge infrastructures.

Notes

1 Closely related to the topic and concept of infrastructure, mainly concerned with social studies of energy, two recent sets of special issues of the *Science & Technology Studies* journal have also developed similar themes, see Silvast et al. (2013) and Williams et al. (2014).

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