

VIRTUAL KNOWLEDGE

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EXPERIMENTING IN THE HUMANITIES AND THE SOCIAL SCIENCES

EDITED BY PAUL WOUTERS, ANNE BEAULIEU, ANDREA SCHARNHORST,
AND SALLY WYATT

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for all of those who contributed to the Virtual Knowledge Studio in the
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INTRODUCTION TO VIRTUAL KNOWLEDGE

SALLY WYATT, ANDREA SCHARNHORST, ANNE BEAULIEU, AND PAUL WOUTERS

This book is about newly emerging forms of knowledge. Since the late 1990s, many scientists, scholars, and funding agencies have paid attention to the application of advanced information and communication technologies in academic research. Initially, this was framed as a revolution to be triggered by computational technologies (NRC 1999). This wave of enthusiasm enabled the mobilization of large-scale resources for the further development of new paradigms in computer science, ultimately leading to the creation of a cyberinfrastructure for research in the United States (Atkins et al. 2003) and the e-science program in the United Kingdom (Hey and Trefethen 2002), among other initiatives. However powerful in attracting resources, this vision tended to reduce the debate to the creation and subsequent uptake of computational tools and network technologies. Not surprisingly, social scientists and humanities scholars, especially those versed in science and technology studies, criticized these approaches from the very beginning as shallow and biased (Dutton 1996; Hine 2006b; Woolgar 2002; Wouters and Beaulieu 2006). After all, knowledge is not a purely cognitive operation of analytical tools on data, but a complex and highly structured set of practices of interpretation (Hackett et al. 2007). The styles of working and reasoning in different fields are quite different, and the differences have been analyzed both historically (Crombie 1994) and sociologically (Whitley 2000; Collins 1998; Knorr Cetina 1999). It therefore seems plausible that the implications of new digital networked research tools and research environments should be different for different fields. Research on the interaction between practices and digital network technologies has confirmed this variation (Virtual Knowledge Studio 2008; Borgman 2007). It is now almost common sense that enabling new forms of knowledge creation via digital technologies is not simply a matter of handing over the technical

tools or a matter of adopting the tools and techniques used in some highly reputed field. Of course, this does not in any way diminish the seductiveness of the promise of the “World Brain” in new guises. Claims of revolution will continue to be made, and they may also play a productive role in generating more resources for research, as promises and expectations tend to do (Brown and Michael 2003). But they should not be taken at face value.

So how should one think about these developments and about the exciting challenges of the information revolution and the data deluges that seem to come with it? To begin, it is necessary to look closely at the practices that are developed and sustained by both “expert” and “non-expert” knowledge creators in a variety of fields. This empirical analysis of how science is actually conducted is, however, not a direct reflection of reality, but a result of interaction between the imagination and expertise of analysts and their objects of research (Woolgar 1988; Ashmore 1989). Every empirical analysis of the purported transformation in research is based on a theoretical framing of what counts as knowledge and as knowledge practices. It is, moreover, based on some theory of (infra-)structure and practice—and of the ways they interact (e.g., Latour 1987; Giddens 1979; Foucault 1966; Rheinberger 1997). In this book—one of the fruits of a five-year (2005–2010) research endeavor at the Virtual Knowledge Studio—we build on this theoretical work to refine the main concepts further. We focus on the quest for new forms of expertise which we call *virtual knowledge*.

Three notions of knowledge have shaped this work. First, knowledge is always inscribed in and by technology and instruments, either social (Derkssen and Beaulieu 2011) or material (Bowker 2005; van Dijck 2007). Second, knowledge is deeply social. For knowledge to be more than simply the record of what an individual knows, it has to be embedded in, and performed by, infrastructures (Star and Ruhleder 1996). Paul Edwards puts it this way: “Get rid of the infrastructure and you are left with claims you can’t back up, facts you can’t verify, comprehension you can’t share, and data you can’t trust.” (2010, 19) Third, the creation of knowledge enters into a cyclical feedback loop in which there is interaction between knowledge and infrastructures, through the practices of knowledge producers and users. In these interactions, new practices co-evolve with new infrastructures. For example, the crucial invention of the European seventeenth-century “scientific revolution” was the creation of science as a new social institution

enthralled by the creation of novelties, stuff that did not exist before (Collins 1998). Today we are witnessing a new wave of changes in the ways scientific and scholarly knowledge are created, codified, and communicated. These transformations are related to the use of digital technologies and to the virtualization of knowledge production. Although we are reluctant to call it a revolution, we do think that these changes are quite profound because they affect the social fabric of science and scholarship.

Scholars, industrialists, politicians, and policy makers are all engaged in discussing, analyzing, and even promoting knowledge-based economies. This book focuses on the question of whether there is anything new when knowledge is produced in the digital age. Does knowledge itself change when the tools with which knowledge is acquired, represented, and distributed become digital? Do new actors become involved, and/or do traditional actors become less prominent in knowledge production? Are there shifts in power relations around knowledge? Are traditional definitions of knowledge affected? What new opportunities might emerge, and how should they be taken up? These questions are addressed in this book in relation to the academic system and to scholarly and professional practices. Change is not always for the better; thus, it is also necessary to raise questions, from the perspective of researchers and from the perspective of society more generally, about what kinds of changes and innovations are desirable and worthy of being promoted. We use the term *virtual knowledge* throughout this book to evoke these questions. Before we explain this term more fully, we will present five vignettes that illustrate the kinds of changes in knowledge production with which we are concerned.

- In 2004, scholars of Dutch language and literature in the Netherlands, in Belgium, and in South Africa were involved in an emotionally charged controversy about the digitization of a major research resource: the Bibliography of the Dutch Language and Literature. Printed versions of it were still being published, though much of the work of cataloguing the material was already being done digitally and there was an email newsletter. Thus, what was at issue was not the use of digital technologies but, rather, how a literary scholar should work in the twenty-first century, and with what sorts of professional support. Long-standing disagreements between literary studies and linguistics resurfaced. Dutch literary study is conducted largely

by researchers who interpret texts on their own. Linguists tend to work in teams, using quantitative methods and supported by an international computational infrastructure. The controversy involved scholarly identities, both individual and collective. The crucial question was not whether the field should go digital, but rather what kind of digitization should be pursued for what purposes and at what costs (Kaltenbrunner and Wouters 2009).

- Historians of global economic history, who used to exchange data in spreadsheet files attached to email messages, are building what they hope will become a sustainable “data hub” with related topic-oriented collaboratories (laboratories without walls spanning institutional and national borders). This is not a simple matter. Those involved are confronted with the need to negotiate how to classify and present data as well as with the social configuration of data sharing. Questions of who can publish what, using what data, and questions about the most effective ways of working in a shared Web-based work space are at the core of what it means to work and be recognized as a historian. Perhaps, in the longer term, this collaboratory-building will change the dominant mode of scholarship from individual authors regularly co-authoring with colleagues of their own choice to large, distributed research teams requiring different forms of management and accountability. Or perhaps the collaboratory will turn out to be a temporary, project-bound experiment without any long-term effect on the structure of the field (Dormans and Kok 2010).

- Individual scholars, using tools now considered mundane, can already collaborate and communicate in creative ways, as the experiences of a prominent women’s studies research group in Europe exemplify. The group’s members did not identify themselves as being in any way related to “e-research,” yet they made innovative use of email lists in research and teaching. Through the use of lists and of supporting websites, these scholars were creating and sustaining national, European, and international networks. The use of these Web-based resources contributed to increasing the visibility and the consolidation of women’s studies. Furthermore, the use of email—widely available to those outside formal academic institutions—made it much easier for feminist activists and others interested in gender equality to participate in Internet-based discussions, thus facilitating wider dissemination and production of knowledge. Changes in knowledge production can therefore occur gradually, without much conscious investment in explicitly technological promises, and even without being recognized as “e-science” or “digitization of the field” (Wouters and Beaulieu 2006).

- New forms of visualization and simulation, some developed by the computer games and entertainment industries and some for military purposes, are increasingly finding application in the social sciences and the humanities. Digital technologies can be used to enhance the presentation and circulation of maps by, for example, visualizing the technical reliability of information. The historical evidence associated with original maps can also be made visible by means of annotations that enable users to establish the suitability of a map for their own research purposes, whether professional or amateur historical or archeological research, or for purposes of restoration. But the reliability of maps cannot be separated from their original functions and contexts of use. By combining (parts of) maps made for different purposes and (re-)used in different historical contexts, “messages” are mixed, making it difficult for users to know how historical information is represented in digital town plans and virtual reconstructions of cities. Using such maps for research and other purposes demands critical skills of users in order to assess the reliability and veracity of historical representations (van den Heuvel 2006).
- With the use of digital technologies almost ubiquitous in advanced industrialized countries, large amounts of data are generated as individuals, households, and organizations go about their everyday activities. These data are routinely collected and processed, not only by academic social scientists but also by market and social researchers in policy settings and in private-sector institutions. In an example of social science research, Peters, Kloppenburg, and Wyatt (2010) combined qualitative and quantitative data in novel ways when researching how people incorporate transport and communication technologies into their busy lives. Both in-depth interviews and numeric data from mobile phone records were used. The availability of such data offers the promise of solving what some researchers see as problems inherent to interviews, such as imperfect memory and socially desirable answers, but it may also exacerbate ethical and methodological problems arising from a lack of contextual information about what everyday activities mean to those engaged in them. Furthermore, even though there are many digital tools that facilitate analysis of large-scale data, the divide between social scientists trained in qualitative methods and those trained in quantitative methods may widen.

These vignettes illustrate phenomena and themes that will recur in this volume. They make visible the diversity of applications, tools, techniques,

software, and hardware that have been described as *e-research* or *e-science*. They also illustrate the variety of changes in knowledge production. In analyzing newness, we concentrate on the makers and the processes rather than on the new products themselves. We are not primarily interested in the new instruments, tools, and technologies *per se*, but rather in the contradictions and tensions scholars face when alternating between the roles of producing knowledge and using knowledge. We pose the overarching question of what is actually new in e-research at three analytically distinct levels (which may overlap in practice): the form and content of research, the practice of research, and the organizational context in which research and knowledge production are conducted. The tensions always present in discussions of the development and use of new technologies—those between transformation and tradition, between change and continuity, between hope and fear, and between control and autonomy—are often expressions of normative struggles. These tensions are important not only for those participating in knowledge production across a variety of settings, but also for those who are the objects of research, and for society as a whole (which invests substantially in research and is the main stakeholder in the production of knowledge).

In the next section, we discuss how the research context in which digital technologies have been developed and used has changed in many advanced industrialized countries. We then turn to the emergence of e-research, focusing on its relationship to related concepts such as e-science or virtual knowledge, and further elaborate on why we use the term *virtual knowledge*. Finally, we outline the contents of the book, not only providing an overview of the chapters but also identifying cross-cutting themes.

THE CHANGING RESEARCH CONTEXT

Long-established hierarchies and practices of scholarly knowledge production are undergoing change, challenged from within and by broader social developments. At a systemic level we can distinguish four developments, which we label *growth*, *accountability*, *network effects*, and *technology*. The first two, associated primarily with the decline of autonomous science in practice and as an ideal, point to the myriad ways in which a wider group of social actors are involved not only in setting the agenda for science but also in knowledge creation itself. The third and the fourth relate to the socio-material relations and to conditions of knowledge production.

First, the growth of the university system after World War II in advanced industrialized countries was part of the overall growth of research and development and was accompanied by a concomitant increase in the diversity of students, staff, and subjects. In the second half of the twentieth century, universities became accessible to a wider range of people. Many new disciplines and interdisciplinary fields emerged, such as media studies, cultural studies, women's studies, and gender studies. Sometimes, as in the case of women's studies, these new disciplines could be attributed to the greater diversity of people entering universities. In other cases, the emergence of a new field is related to the widespread availability of a new object or medium, such as television in the case of media studies. Promoting interdisciplinarity is not new, and it can be used to disrupt power relationships in a field by uprooting extant research practices and norms of quality and relevance. The push to become interdisciplinary, sometimes by importing instruments and ways of working and thinking from other fields, can be instigated by funding agencies, organizations of researchers and individual scholars. If it is successful, those involved become pioneers. If not, the experiments and those promoting them tend to be erased from the disciplinary collective memory, perhaps to become objects of research for future historians of science (Joerges and Shinn 2002). Over the same period, the institutional frames for knowledge production have changed and new forms of governance and organization have emerged (Stichweh 1996).

Second, and related to new institutional forms and modes of governance mentioned above, researchers are increasingly called to account for the quality and quantity of their output and its relevance for non-academic social actors. National and international science and other policy makers have played an increasingly important role in steering and evaluating academic output in both teaching and research. A wider range of social actors, including for-profit corporations as well as civil society organizations, are no longer simply the passive recipients of knowledge produced elsewhere but are increasingly active in its production. Though many positive outcomes can be observed arising from new forms of governance and participation, modes of accountability nevertheless have a range of effects on the work of scholars and on institutions (Strathern 2000).

Third, the apparent success of "big science" in the physical and biological sciences in the postwar period means that large teams working across institutional and disciplinary boundaries have become the ideal for research

managers and policy makers. Makers of science policy have been promoting particular forms of work organization by investing in research infrastructures and by encouraging large-scale, interdisciplinary and/or international collaboration (Bell, Hey, and Szalay 2009; Hine 2008; Edwards 2010). Not only has networked research emerged as a new ideal organizational form; network science, as a new research field that systematically analyzes network effects in nature and society, has grown. Moreover, the diversity of research networks has increased, partly as the result of increased collaboration between publicly funded research institutions and for-profit companies.

Fourth, as the vignettes above illustrate, digital technologies have been taken up in all stages of knowledge production (Hine 2005; Jankowski 2009; Virtual Knowledge Studio 2008). Furthermore, digital technologies have a role to play in the processes mentioned above. Digital technologies shape collaboration, monitoring, and evaluation and the communication of results, both within the scientific community and to wider audiences. This fourth development is the main focus of this book.

The implications of growth, globalization, commercialization, and digitization for the natural sciences and for engineering have already received a great deal of attention in the literature. They have been given various labels, including *Mode 2* (Nowotny, Scott, and Gibbons 2001), *post-normal science* (Funtowicz and Ravetz 1993), *technoscience* (Latour 1987; Haraway 1985), and *the triple helix* (Leydesdorff and Etzkowitz 1998). Their counterparts in the social sciences and the humanities have not been studied as systematically. This volume aims to help remedy that.

We start from the observation that the social sciences and the humanities (SSH) are also undergoing profound changes that bring to the fore the very notion of knowledge. Growth, accountability, network effects, and technology, the four developments outlined above, also affect SSH. But, given that society and the products of human creativity and interaction are the main objects of study in SSH, the implications of changing the modes of governance and organization are likely to be different for SSH than for natural sciences and engineering. Changes in society not only reconfigure the conditions under which new knowledge is produced; they are, at the same time, objects of study. The tools and methodologies used to gain knowledge change, but these changes also affect the object under study (Giddens 1984). These changes take place concurrently and interactively, though not always in the same direction or at the same rate. These changes cannot simply be

reduced to developments in research technologies (although some policy actors certainly think they can). However, analyzing the use of technology provides a valuable analytical focus, giving indications about changing circumstances of use and of how traditional hierarchies, locations, and processes of knowledge production in SSH are being disrupted.

There are a number of analytical advantages to taking technology as a starting point when striving to understand changes in SSH. As was mentioned above, it is not the technical tools *per se* that are most interesting but the ways in which new technologies stimulate reflection about objects, methods, and practices of research. First, most efforts to use digital technologies in research involve the formalization of research practices and of research objects (van Zundert et al. 2012). Such processes require actors to consider their practices and negotiations about standards for communication or for data formats. These processes make explicit aspects of research and values of research communities, which themselves provide an interesting starting point for analysis. Such negotiations may enhance the reflexivity of practitioners and the likelihood of being able to enter into discussion with them about their work. Second, in part because the infrastructures were first adopted in physics and computer science, digital infrastructures tend to be built at scales that are “large” by SSH standards. Coalitions across institutions and disciplines are thus needed to reach the scale at which infrastructural projects are pitched by funding agencies, resulting in encounters between epistemic cultures. Such processes are again moments when differences within SSH become visible to the analyst. Third, e-research and e-science projects provoke hopes, resistance, and controversies. Controversies have a long tradition in STS and in history of science as moments that are analytically rich (Martin and Richards 1995). They have also been identified as “early warning indicators” for the development of new ideas, emerging paradigms, and methodological innovations. When scholars become involved in ongoing controversies, they can play a role in articulating what is at stake for actors, thereby opening up the possibility of analytically informed interventions.

As was mentioned above, there are already a number of concepts in circulation, including Mode 2, post-normal science, and technoscience, that aim to convey how knowledge production has been changing in recent decades. There are also a number of more specific concepts, including cyber-science, e-science, and e-research, that aim to capture how digital technologies have affected the research process. In the next section, we discuss these

more fully and explain why the concept of virtual knowledge best captures the interplay between the various changes that can be observed in the social sciences and in the humanities.

THE EMERGENCE OF VIRTUAL KNOWLEDGE

In the course of the research presented in this volume, a wide variety of terms have been encountered in different settings, whether used by actors in the field (*e-science*, *cyberinfrastructure*, *grid*, *semantic web*), used by colleagues in academic discussions (*digital humanities*, *computational humanities*, *collaboratories*, *virtual research environments*), or generated by us in the course of our work (*e-research*, *virtual knowledge*). At times these settings have overlapped considerably. Each of these terms (and their use in paired opposition) has a particular connotation, and none of them arrive free of history and context. Some of these histories have been recounted recently—for example, by Jankowski (2009) for e-science and e-research, by Borgman (2007) for cyberinfrastructure and digital scholarship, and by Hine (2008) for cyberscience. (See also Nentwich 2003.) These histories are especially interesting and important because these terms have been used to articulate the promises of change in relation to technology (Brown and Michael 2003; Hine 2006a). Though we will not recount all the histories here, the contributors to this volume signal and contextualize the uses of terms that have played such promissory roles, and make explicit their decision to take on these vocabularies. Instead of trying to set definitions in stone, it is more important to interrogate the use of these terms, especially their use to evoke positive or threatening futures for those who encounter them.

In this section, we focus on two of these labels. We choose to do so because they play an especially important role in analyzing the developments under discussion and in positioning the contributions of this book as a whole. The first is *e-research* (Jankowski 2009; Wouters 2004; Wouters and Beaulieu 2006; Virtual Knowledge Studio 2008). The use of this term brings the practice of research to the fore rather than hardware or infrastructure, and acknowledges forms of research that are not reliant on high-performance computing, thereby including the use of new media and digital networks. We have used *e-research* to indicate an object of research and intervention that would be more inclusive of a variety of research modes (Wouters 2004). Sensitivity to disciplinary practices (Fry 2006; Kling and

McKim 2000) is therefore a central assumption in the use of this term. Because of the analytic terrain this term opened up, it seems to have become far more widespread recently. Most significantly for the point to be made here, we use *e-research* specifically in contrast to *e-science*, which emphasizes data-oriented, computational, or quantitative analysis. Not only does this oppositional redefinition enable us to evoke an interesting object of study; it was also important in establishing the mission and research program that led to much of the work presented in this book (Wouters 2004).

The second term we wish to discuss is *virtual knowledge*. We use this term to characterize the contents and object of this book. Both words, ‘virtual’ and ‘knowledge’, denote important analytic and theoretical decisions, as well as a sensitivity to the context of our work. *Knowledge* may be a better term for the practices that interest us, because it is both broader than *research* and closer to the perception that the humanities are engaged in scholarship rather than research. Furthermore, whereas research can be seen as a rather specialized activity pursued largely in academic institutions or in corporate labs, knowledge enables us to incorporate a wider range of social actors and practices.

To speak of *the virtual* is also to use an evocative term, and to signal one’s analytic distance from the technological. Although in the 1990s the term *the virtual* was associated mainly with digital environments and with simulated spaces such as “virtual reality,” it is broader in meaning than *the digital*, or *simulation*, or *the artificial*. An important line of thought on virtuality emphasizes that the virtual is a mode of reality implicated in the emergence of new potentials (Massumi 1998). In this sense, virtual knowledge is not simply the use of a digital tool; it is also the potential for change that it carries. We approach e-research empirically, combining our commitment to study practice and use with attention to the power and transformative potential of the virtual. To address the virtuality of knowledge empirically means that we consider the very actual, material, institutional implications of such potential. These are, in each particular case, limitations on virtuality, since the actual situations we analyze constitute an instantiation of virtuality. Virtuality is generative of all kinds of changes in practice. Contributors to this volume constantly pose the question “What is really new?” To ask this question is to engage with the potential for change while seeking to witness it.

The term *virtual knowledge* therefore invokes creativity, potential, and dynamism in combination with actual practices and understandings. It also

emphasizes the ongoing dynamics of change, both in the form and content of knowledge and in the craft of generating new knowledge. When we speak of our work as simultaneously *being* virtual knowledge and being *about* virtual knowledge, we emphasize that it is both an ontological and an epistemological concept. We therefore emphasize that our concerns encompass the changing core of how others, as well as ourselves, pursue science, research, and scholarship, while being aware of the situatedness of any such changes. Virtual knowledge is not “just” about data, tool, or method; it is also about the epistemological and ontological consequences of the changing conditions of knowledge production. Virtual knowledge signals a new attention to the becoming of such potentials, and to the consequences of virtual knowing.

Virtual knowledge is strongly related to the notion that knowledge is embedded in and performed by infrastructures. In his recent book on the history of climate science, *A Vast Machine*, Paul Edwards points to the centrality of infrastructures in knowledge and in society: “To be modern is to live within and by means of infrastructures: basic systems and services that are reliable, standardized, and wisely accessible, at least within a community.” (2010, 8) Infrastructures are noticed only when they fail, but they are usually transparent and taken for granted (Star and Ruhleder 1996). It is mainly in the form of newly emerging infrastructures that virtual knowledge becomes real. Many e-science programs claim to build the scientific infrastructure of the future. As Edwards has shown, this is a misnomer. Infrastructures cannot be built; they can only evolve. We would go even further: In the best case, they co-evolve with the research practices they aim to support. Rather than decouple infrastructures from research practices, it is better to state that what most e-science programs have built are systems and tools—potential components of new infrastructures that may or may not be included in the evolving knowledge infrastructures. The infrastructures that are now taking shape are not developed to support well-defined research projects as to the generation of streams of yet undefined research. Most of the data infrastructures that have been built so far have promised the discovery of new patterns and the formation of new data-driven fields of research. Networks of young researchers hope to generate new combinations of very different disciplines. New funding schemes specifically target unusual combinations of people, machines, and institutions. Increasingly, infrastructures and their component network technologies try to support possibility

rather than actuality—though, as these chapters show, certain possibilities are better supported by the kinds of infrastructures being developed. This is underlined by the term *virtual knowledge*. How to further develop and sustain this type of knowledge is as much an empirical question as a theoretical one.

OUTLINE OF THE BOOK AND COMMON THEMES

In this book, the emergence of virtual knowledge is examined from a variety of perspectives, using many different empirical examples. Insofar as virtual knowledge is itself characterized by diversity, it makes sense to examine its emergence from different disciplinary, methodological, and empirical perspectives. Two main themes frame the contributions. The first is how novelty and promises of novelty are themselves deployed in the discourses and practices accompanying the introduction, the diffusion, and the use of the wide range of applications, tools, and techniques that can be collectively described as virtual knowledge. The second theme is the normative implications of these changes, what they mean for winners and losers in the changing landscape of knowledge production, and whether the reconfiguration of academic autonomy in favor of more involvement from non-academic actors results not only in purported democratization but also in better knowledge. Thus, the contributions are explicit about the emergence and implications of the changes they describe. Each chapter draws on one or more examples about the form and content of research, about the practice of research, or about the organizational context in which research and knowledge production are conducted.

In line with the contemporary orthodoxy in science and technology studies (STS), the chapters are based on empirical research. STS has been very successful in developing theoretical and methodological tools for analyzing epistemic cultures and practices, drawing attention to local contingencies and specificities. Also in line with STS, contributions include insights from other disciplines—especially history, information science, and cultural studies. The volume adds to STS through its focus on the social sciences and the humanities, hitherto neglected in comparison to the huge number of studies in STS about natural, engineering, and medical sciences. This book is also a contribution to a more recent development in STS that distances itself from the single case study (Wyatt and Balmer 2007) and puts more emphasis on using comparative analysis to draw out common themes. The

book shares this trait with recent books on e-research that have aimed to give a critical overview of a large number of recent developments and interesting case studies (Dutton and Jeffreys 2010; Hine 2006a; Jankowski 2009). For example, Dutton and Jeffreys ask how “technical change in research is enabling the reconfiguration of access to information, expertise, and experience across the disciplines.” Jankowski (2009) draws attention to the ways in which change is dependent on disciplinary and other contextual factors, and suggests that change in scholarly practice is gradual. Access is a central theme in all of these books. Interestingly, Jankowski performs this theme by freely providing an “enriched publication” on the Web (<http://scholarly-transformations.virtualknowledgestudio.nl/>). We also share the critical perspective, developed by Hine (2006b, 2008), in which practices and promises are confronted with each other. Our book adds to the current discourse by shedding light on practices that have not yet received much attention in the debates on contemporary changes in knowledge making—changes that may or may not lead to more fundamental epistemic transformations.

Each chapter in this book integrates several case studies and theoretical approaches revolving around a particular theoretically relevant theme. The book is not formally divided into parts or sections; however, there is a logic guiding the order of the chapters. Chapter 1 questions the novelty of recent developments and the book ends with a chapter focused on the future. In the first chapter, Anne Beaulieu, Sarah de Rijcke, and Bas van Heur argue that the “realization of promise” and emerging forms of epistemic authority are shaped by pre-existent institutional and infrastructural elements. The chapter is based on three case studies of new networked sites of knowledge production: the collection database of an ethnographic museum, the use of the photo-sharing site Flickr by researchers and professionals concerned with the phenomenon of street art, and the development of a municipal website to support local cultural heritage. The analysis of these cases explicitly challenges the popular claim that new technologies will radically reconfigure existing sociotechnical relations and dramatically alter the basis for scientific and scholarly authority. The chapter shows the importance of the constitutive tension between reproduction and innovation in thinking about new sites of knowledge production and the forms of authority and expertise they sustain.

In chapter 2, Smiljana Antonijević, Stefan Dormans, and Sally Wyatt focus on the everyday work practices of scholars in the social sciences and

the humanities. The topic of that chapter—affective work in professional relationships—is rarely addressed in scholarly studies of e-research and information technologies. Antonijević et al. draw on debates about immaterial and affective labor in order to present a set of conceptual tools for understanding the range of tasks involved in scholarly collaboration and how they are affected by the use of digital technologies. Their analysis is based on their research on large-scale international collaborations among social and economic historians and on their own smaller-scale cooperation in writing their chapter. They distinguish among care work, articulation work, and persuasion work, all of which are being affected by the introduction of digital technologies, with consequences for the ways in which some work and some workers are visible and valued. Their analysis also contains some thought-provoking messages for system builders and e-researchers alike. And by asking if invisible work should perhaps not better remain invisible, they also question the current trends in research evaluation and assessments in which visibility is *de rigueur*.

In chapter 3, Matthijs Kouw, Charles van den Heuvel, and Andrea Scharnhorst address, at an epistemological level, the issue of what counts as valid and valuable. They explore how uncertainty can be a source of knowledge rather than simply a sign of lack of knowledge. They also argue that the natural sciences and the computational sciences have a lot to learn from the humanities, thereby inverting the usual hierarchy in the sciences. After reviewing recent debates about the role of uncertainty in knowledge practices in the natural and social sciences, Kouw et al. present three examples from the history of information sciences, the history of architecture, and the history of complexity research. The examples concern the role of data and classification, the design of interactions, and the inclusion of dynamics in formal approaches to complex systems. Using these examples, they reflect on how people involved with e-research in the humanities and social sciences and people working in multi-disciplinary environments can engage uncertainty and appreciate its productive and disruptive effects, especially in the areas of interfaces, interactions, and models.

Yet another dimension of what it means to make something visible is explored by Rebecca Moody, Matthijs Kouw, and Victor Bekkers in chapter 4, the topic of which is the policy dimensions of visual knowledge. Moody et al. address how the introduction of a new technology (in their case, geographic information systems) challenges ways of producing and

using knowledge in policy-making settings. They discuss a theoretically and methodologically novel approach to public administration and management made possible by the availability of geographic information systems; they also discuss the increased challenge of mastering complex interwoven natural, economic, social, and political networks by governmental organizations. In doing so, they combine insights from governance studies with science and technology studies. Using examples from water management, concentrations of particulate matter, and contagious livestock diseases, Moody et al. illustrate the barriers and potentials of new technologies in policy settings. They argue in favor of implementing new technologies in a theoretically well-guided way that roots new possibilities for conveying knowledge in existing and emerging social systems.

In chapter 5, Clement Levallois, Stephanie Steinmetz, and Paul Wouters examine the challenges facing social sciences as a result of “data floods,” the massive increase in the quantity of data available to researchers arising from the use of new technologies. Focusing on the use of Web-based surveys in sociology and the use of brain imaging data in economics, they address the implications of emerging forms of data-intensive research for the role of social theory in e-social science. They argue, in line with the overall argument of this volume, that what is taking place is not so much a shift from one paradigm to another as a complicated set of changes at the interfaces between disciplines. They deal with virtual knowledge in two ways. They discuss the implications of virtual technologies and of data about social transactions embedded in these virtual technologies for sociology and economics. They also posit that the claim that the data deluge disempowers theoretical discourse in academic sociology and economics hasn’t yet been realized and may never be realized, though it still affects the researchers’ self-esteem in these fields.

In chapter 6, Clifford Tatum and Nicholas Jankowski take as their starting point the ongoing crisis in scholarly communication associated with increasing costs of periodicals, the growth of scientific literature, and the transitions to digital environments. They then elaborate the concept of openness, and use it to analyze emerging forms of formal scholarly communication, such as publication of journals and monographs that are solely Web-based, and to analyze rapidly proliferating new forms of informal exchange, such as blogs, social networks, and discussion lists. They consider whether new digital technologies may give rise to new forms of scholarly communication, blurring the traditional distinction between formal and informal modes

of scholarly exchange and between scholarly communication and research practices. Their focus is on openness, perhaps one of the concepts most frequently invoked in the scholarly debate on e-research. Tatum and Jankowski contribute to the debate by analyzing openness both as an infrastructure and as an interface.

In chapter 7, Jan Kok and Paul Wouters return to the role of visions and expectations in shaping the ways in which research is conducted. In doing this, they examine how promissory documents that have shaped e-science, cyberinfrastructure, and e-research as a whole (discussed at the beginning of this introduction) affect a specific field. They analyze the role of technology in shaping research agendas in the history of the family, a field at the interface between the humanities and the social sciences. The authors examine the visions and “dreams” of researchers and policy makers as a way of understanding how research agendas and research technologies are intertwined. They excavate these visions by combining the sociology of expectations with elements of narrative analysis and of studies of science, technology, and innovation. This most explicitly future-oriented chapter goes well beyond family history and examines the constructive role of visions in the development for new research ideas, which is often accompanied by a struggle for new research technologies. The generative potential of the virtual in the form of research dreams and proposals for new infrastructures is real, irrespective of its later success. Even if a particular expectation isn’t met, it has real consequences for the field.

The book has two overarching themes: the novelty and promises of novelty associated with e-research and the normative implications of their realization. These themes are addressed at three levels: that of form or representation, that of the content of research or disciplinary commitments, and that of the organization and the practice of research. By focusing the practice of research, contributors are able to analyze transformative changes and continuities in the creation of scholarly knowledge. This allows the contributors to draw upon a range of approaches, including technologically oriented ones, without falling into the trap of technological determinism (Wyatt 2008); it also allows them to draw on cognitive approaches, which start from theoretical or methodological concerns particular to individual disciplines.

The first theme regarding the promise of novelty appears in all chapters. Individually and together, the chapters call for a historical perspective

comparing the novelty of virtual knowledge with earlier revolutions, paradigm changes, and visions. Chapters 3 and 7 show the value of considering how new research practices are embedded in past ones, allowing for comparison and points of reference. Though the explicit claims and the most prominent promises of e-science tend to be easiest to deconstruct, a focus on practice can help identify novelty in relation to new technologies. By considering the low-level and mundane aspects of research practices, we highlight the really novel, which often takes unexpected forms (chapters 1 and 2). Furthermore, the “new” in e-research ranges from new theoretical frameworks (chapter 4), the epistemic challenges (and even dangers) resulting from new data (chapter 5) to imagined and practiced forms of navigating through information and knowledge (chapter 3), and new modes of publishing and presentation (chapter 6). The quest for the new in e-research practices is simultaneously the quest for the sustainability of virtual knowledge.

Our diachronic perspective on the practice of e-research and the emergence of virtual knowledge draws attention to the importance of temporality. Temporality can be a cause of friction in the adoption of new research practices as discussed by Beaulieu et al. in chapter 1. In that chapter, the tension between the relative temporal stability of institutions and infrastructures and the more fluid dynamics of interaction around Web and digital projects are analyzed. Temporality (more specifically its control in mathematical models) is also a driving force for new forms of knowledge visualization. To contrast change against stability, and to choose the appropriate elements for both, is a major challenge for information sciences (chapter 3).

Modes of research become visible when one is discussing the role of data, the “beyond data” questions, and the data-driven paradigm of e-research (chapter 5). In chapter 7, Kok and Wouters explain how new forms of data may trigger epistemic changes in a field. In most accounts of e-science, especially those originating from life sciences and physics, data are presented as the driving force behind new divisions of labor (chapter 2) and professional practices. But new research practices also create new forms of data, such as research notes in the form of blogs (chapter 6). Data can take different forms, including numbers, text, and images (chapter 3). By following the shape and the role of data in knowledge production, the variety of e-research practices becomes more prominent. The possibility of switching between different forms of data representation itself has consequences. As Moody et al. argue

in chapter 4, visualizing data can have a major effect on the actual selection of data and thereby on the empirical ground and the theoretical framework of a field. The availability of new data or new methods highlights their role as communication devices within and across disciplines.

Although data may be visual and visualizations may drive data selection, the epistemic role of visualizations is also addressed in several chapters. Visualizations are not simply representations; they carry their own epistemic potential, and they have a much longer history than text. Visualizations that are legitimate in one research tradition may lead to controversies when imported into another field, and may also open up knowledge production to new audiences (de Rijcke and Beaulieu 2007). Kouw et al. provide examples of the epistemic role of representations in their account of the production and consumption of uncertainties and the ideal of “complete knowledge.” Beaulieu et al. bring another aspect to the fore in their discussion of the apparently easy availability of visual material in digital settings, which creates challenges for cross-institutional and cross-disciplinary work in networked environments. Moreover, as Moody et al. demonstrate, skill and craft are needed by individuals and teams to produce visualizations that subsequently shape the way scholarship is understood and agreed upon. Technically mediated collaboration challenges existing divisions of labor and reconfigures the nature and distribution of affective labor (chapter 2), and not only in relation to visual material.

Analyzing the role of creative labor in the cycle of value creation in society draws attention to the limits of the economization, valorization, and accountability of research (chapter 2). The tension between self-exploitation, academic freedom, collectively produced knowledge, institutional boundaries, and societal recognition influences what is accepted as knowledge and the demarcation of research and scholarship. Digital settings do not mean that the social dynamics surrounding disputes about what counts as authoritative knowledge disappear, nor do they render knowledge and its production in completely transparent ways (chapter 1). Who counts as a researcher? What is academia? What roles can and do academic institutions play in the production of knowledge and innovation? How does virtual knowledge affect the relationship among social sciences, humanities, and other forms of knowledge production? This book traces the emergence of virtual knowledge in the humanities and the social sciences and shows what is at stake in pursuing and studying it. Ultimately, in the chapters that follow, the

normative dimensions of what these changes mean for the future of the social sciences and the humanities come to the fore.

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