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Reflexive inertia : reinventing scholarship through digital practices

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Citation

Kaltenbrunner, W. (2015, May 27). *Reflexive inertia : reinventing scholarship through digital practices*. Retrieved from <https://hdl.handle.net/1887/33061>

Version: Corrected Publisher's Version

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Issue Date: 2015-05-27

Introduction

The success of digital scholarship - an unexpected turn of events

Digital scholarship in the humanities has a much longer history than traditionally trained scholars and casual followers of higher education debates might realize. Arguably the earliest instance can be found in the machine-generated, systematic word index of the writings of St. Thomas that the Jesuit Roberto Busa created for his doctoral research in the late 1940s (Busa, 1980; Hockey, 2004). Busa, who is now widely credited as the foundational figure of digital humanities, used this concordance to develop an argument about the composition and structure of the Church Father's language, which in turn served him as a basis for engaging with hermeneutic debates in theology. The first attempts to apply computers in the disciplines of linguistics and history date back to the 1950s (Boonstra, Breure & Doorn, 2006). Linguistics has a long tradition of using large language corpora for statistical analysis (see Swadesh, 1952), and computational analysis provided a useful way of accelerating research as well as broadening its empirical scope.¹ Social and economic historians again showed interest in using digitized demographic information, tax records, and other data collected by public administrators to replace the heroic simplifications of 19th century historiography with more detailed and comprehensive accounts (Boonstra, Breure & Doorn, 2006; Kok & Wouters, 2013). The terms most commonly used to summarize such work - 'history and computers' or the more encompassing 'humanities computing' - drew attention to the novelty of modern information technology as an artifact in everyday scholarly practice. Similar to current discussions, early efforts in digital scholarship were characterized by sometimes bold visions of what computers can do for the humanities. At the same time, these were primarily formulated by practicing researchers and often strongly embedded in the discourse of their 'home discipline'. Scholars of social history for example used computational approaches to extrapolate existing research questions through larger quantities of empirical material than previously possible, and bible scholars considered digital indices verborum primarily as the logical, more powerful extension of print concordances.

1 A foundational research problem for the related field of language technology was the development of automated techniques for translating scientific literature from Russian into English (Hutchins, 1999).

Throughout the second half of the 20th century, the development of digital scholarship followed a relative steady course. The use of computational approaches in the humanities was generally perceived as rather exotic by the vast majority of traditional scholars, posing not least a risk for disciplinary career development (see Nyhan, 2012). Rather unexpectedly for all, however, digital scholarship has begun to attract significant amounts of funding and public attention over the course of the last fifteen or so years. A range of new appellations have recently been proposed to replace the older term humanities computing: e-research, e-humanities, and, by far the most common, digital humanities. In 2010, the *New York Times* featured a series of articles in which several well-known instances of data-driven scholarship are presented as a model for what academic work in the humanities will look like in the future (Cohen, 2010). The application of computational methods to scholarly research problems is moreover one of the few areas of humanistic inquiry that have actually grown in terms of institutional presence and volume of public, private, and philanthropic funding (Gold, 2012). Yet at the same time as it has gained wider currency, the authority to define the essence and boundaries of digital scholarship is no longer exclusively with the individuals who practice it. In the words of Matthew Kirschenbaum (2012), the term digital humanities has become 'a free-floating signifier', which does not primarily denote a particular methodological approach within a discipline or field of research, but also serves as a label for a wider discussion about the future of the humanities that prominently involves research policy and funding bodies. Perhaps precisely because of its lack of specificity, the 'digital' can connect researchers, funders and policy makers in expectation scenarios, thus providing a refracting lens through which those actors reimagine and gradually change what it means to do scholarship in the humanities.² In the language of actor-network theory, we could describe current events as a multitude of simultaneous translation processes (Callon, 1986), in which technologically mediated research practices, institutional arrangements, and relations between different actor groups are reconfigured.³ However, it would seem naïve to think of this

2 Hine (2008) makes a similar argument for the role of ICT in the disciplinary reorganization of biological systematics.

3 Actor-network theory is one of the most influential approaches to social theory of the last decades. Its main conceptual argument is that reality can be thought of as material-semiotic networks that distribute agency across both human and non-human entities, such as material objects, texts, and institutions (Callon, 1986; Latour, 1999; Law, 2004). Networks emerge through the efforts of entrepreneurial individuals, for example scientists, who

process as a transition towards a singular new model of digital scholarship. Rather we are likely to see competing attempts by different actors to seize the current opportunity and change the organization of academic life in the humanities according to their respective interests.

In terms of intellectual aspirations, practitioners of digital scholarship adopt diverse positions. They include computationally intensive research in an empirically oriented tradition⁴, but also initiatives in what could perhaps be termed digital poststructuralism. Intellectual goals are of course often difficult to separate from institutional and professional interests. In fact, the current popularity of digital scholarship, and its status as a recipient of funds to “bring information technology into the humanities” (Liu, 2005: 11) has not least been a result of earlier struggles to reposition humanities computing in the institutional hierarchy of the academic system. This can be gauged by looking at the short history of the term ‘digital humanities’. Many of its now famous North American representatives started their careers in IT support centers that had originally been set up as service providers to faculty researchers (Nyhan, 2012; Flanders, 2011). Intent to consolidate these centers as an academic workplace that would allow to combine service functions with more explicitly intellectual ambitions, digital scholars increasingly took issue with the label humanities computing, which in their view had become widely associated with an auxiliary activity that merely ‘facilitated’ the work of other researchers (Kirschenbaum, 2010; 2012). Instead, they wanted to underline that the dedicated use of digital technology makes for a fundamentally different practice that mediates and shapes the very intellectual substance of scholarship. The term digital humanities, originally used in various pioneering institutions in the US, was gradually adopted as a more desirable alternative that suppressed the connotation of service work.

Apart from dedicated efforts in which novel technology is given a central role in the organization of the research process, there is currently a large majority of scholars who apply digital tools in more basic ways (see Bulger et al., 2011), for example by using digital library services, social media, or networked reference management software. However, digital

selectively enroll human and non-human actors and subsequently draw boundaries between elements designated as either ‘natural’ or ‘cultural’ (Latour, 1993). While not at the heart of my theoretical framework, I will variously refer to actor-network theory in the following chapters.

4 See for example publications in the journal *Literary & Linguistic Computing*, a longstanding outlet for computationally intensive research in the humanities.

scholarship has stimulated reflection not only in terms of its potential beneficial effects. In fact, its very success in attracting public attention and funding has also generated a certain suspicion in recent years. A number of renowned academics have expressed discomfort about a seeming proximity of the digital humanities to neoliberal approaches to research management (see Pannapacker, 2013; Chun, 2013), for example in terms of the distinctively upbeat, promotional rhetoric by which some digital scholars present their work in the media (Cohen, 2010), the coincidence of policy calls for more collaboration in research and the traditionally project-oriented format of most digital scholarship, or the pronounced pragmatism and aversion to high theory displayed by some influential practitioners (Scheinfeldt, 2008).

An important background for the policy interest in digital scholarship is provided by the many digital infrastructure projects currently underway in Europe, the US, and Asia. These aim to create a pervasive technical basis that would allow researchers from all fields to draw on large amounts of data, get access to sophisticated analytical tools, as well as technologies for facilitating collaboration across disciplines and countries. Digital scholars are often the primary beneficiaries of the grants disseminated by such project frameworks, since they have a longstanding experience in the development and application of research technology. Particularly influential in promoting the idea of digital infrastructure has been a report authored by computer scientist Dan Atkins and his colleagues (2003) for the National Science Foundation (NSF). Introducing the popular term cyberinfrastructure, Atkins et al. argue that investment in digital infrastructure is absolutely indispensable if the US wish to retain their position as the scientifically most productive nation in the 21st century. In 2004, the NSF acted on their recommendations by setting up a specialized division that distributes grants for infrastructure projects in various disciplines of science and engineering. The National Endowment for the Humanities created a complementary unit, named Office for Digital Humanities, in the following year. In Europe, digital infrastructure projects are connected to the idea of integrating the various national research systems into a European Research Area, thus increasing their research performance as well as the translation of basic science into economically viable innovation (EC, 2000; ESFRI, 2006a). Respective initiatives can in several respects be seen to intervene into the organization and practice of humanistic inquiry (Beaulieu & Wouters, 2009; Barjak et al., 2013). The European Strategy Forum for Research Infrastructures (ESFRI), set up in

2002 by the European Commission and Council of Ministers, offers not only new grant opportunities for digital scholarship and the development of digital research tools, but also coordinates these activities by issuing a regularly updated roadmap. Funded projects are typically expected to create reusable digital resources. Specific funding decisions will moreover be informed by rationalizing considerations, for example regarding the relative redundancy or complementarity of a prospective new research tools in relation to already existing facilities (cf. Zorich, 2008). The policy perspective of digital infrastructure thus has certain consequences for research governance: it refracts the organizational structure of the humanities in such a way as to foreground a shared layer of analytical applications and datasets, which can then be applied according to the specific needs of the user. This will create a certain tension with the way many scholars view their activities. Especially if they are not yet initiated to digital research practices, they are likely to think about their work in terms of longstanding disciplinary traditions, theories, and methods, as transmitted through institutionally embedded curricula, rather than in terms of an underlying layer of shared digital data that must be used as efficiently as possible. Other scholars again may agree with research policy and funding bodies on the need to create digital infrastructure, but in so doing may pursue different normative and intellectual priorities.

Particular conceptualizations of digital infrastructure also have epistemic implications. In many cases, research policy associates the development of digital infrastructure with the expectation that it will make research in the humanities more data-driven, and less hermeneutic. The idea here is that the availability of digital data and analytical tools will enable scholars to make firmer claims with respect to their research questions. For example, the prestigious funding framework Digging into Data – a joint initiative pooling resources by four international funding bodies – takes its participating projects as proof that the humanities are no longer adverse to the use of technology, and by now underway to embrace computationally intensive research. The report insists that such research constitutes a singular culture of e-research, in which the bifurcation of the humanities and sciences, as (in)famously posited by C.P. Snow, is no longer existent (Williford & Henry, 2012: 7). Similarly, British attempts to create digital infrastructure for humanities scholarship were originally a byproduct of the UK e-science program. The latter is strongly informed by the needs of data-intensive fields like particle physics, astronomy, or genetics, and its leading promoters usually are computer scientists with distinct computer science

research agendas (Hey & Trefethen, 2002; Hey & Trefethen, 2005; Wouters & Beaulieu, 2006). Although there have in the meantime been dedicated efforts to make the specific features of humanities scholarship a more important consideration in the design process (Anderson, Blanke & Dunn, 2010), the British concept of digital infrastructure as a source of high-performance computing and large-scale datasets is still indicative of its original modeling on particular natural sciences. To give a third example, efforts to promote digital scholarship in the humanities in the Netherlands are funded under the title of computational humanities. Conceptually very similar to the above mentioned efforts, the Dutch approach is moreover particularly explicit about the goal of using digital infrastructure to reduce the organizational fragmentation of the humanities. An underlying assumption is that computational humanities can remedy what research policy perceives to be a lack of internal coherence of humanities scholarship in the Netherlands (Willekens et al., 2010).

If it is analytically useful to think of current developments in digital scholarship as a multitude of simultaneous translation activities, then it is also important to operate with a sufficiently complex idea of the object that is being translated. Drawing on a range of complementary theoretical traditions, I will in the following section develop a conceptual view of the humanities as a knowledge-producing machine⁵, which has developed historically into its current configuration. This machine consists of many moving parts – institutional mechanisms by which disciplinary practices and identities are reproduced, established epistemic and methodological conventions that are embedded in material tools, and nationally specific relations between researchers, funders, and policy makers, to name but a few. The complex, distributed nature of this machine also implies that its

5 The literature on infrastructure studies, which provides the main conceptual source for my own theorizing, is characterized by the use of both organic and mechanical metaphors. Star & Ruhleder (1996) for example picture distributed but interrelated practices as an ecological system that develops in an evolutionary fashion. Drawing on Hughes' (1983) foundational work on large technical systems, on the other hand, Edwards (2010) and Edwards et al. (2011) visualize scientific networks as a complex machine or engine that is developed in small, adaptive steps. In this thesis, I use both organic and mechanical metaphors so as to draw out different conceptual aspects. The ecological metaphor has the advantage of stressing the delicate balance of practices, while the notion of evolutionary change has an unfortunate connotation of inevitability. By contrast, while perhaps less effective in conveying a sense of mutually sustaining practices, the metaphor of a machine that undergoes partial modifications usefully emphasizes the need for intentional, reflexive human agency.

functioning is characterized by a certain inertia.⁶ Modifying or rebuilding it is not something that can be achieved by an isolated, centrally operating engineer, however skilled he or she might be. This inertia should not be seen as a negative feature. After all, it is what ensures that distributed practices are compatible, and that individual knowledge contributions form more or less coherent intellectual traditions. It also means, however, that incorporating new parts – for example in the shape of new tools and digitally mediated practices – must be done with circumspection for the history and complex design of the machine. Adapting a metaphor from Edwards et al. (2011), we could think of such reflexivity as a lubricant that allows to develop its mechanics without producing a jam due to carelessly fitted new parts.

New tools, new knowledge?

When reimagining scholarship as a digitally mediated activity, actors make implicit or explicit assumptions about the relation between changes in research technology and changes in the research process itself. These assumptions may often have an important effect on practical strategies for implementing digital tools in established practices. For example, the promise of a technology-induced, revolutionary change in the epistemic fabric of scholarship logically suggests an approach of concentrating technical expertise and funding in the framework of a centrally managed digital infrastructure project. I would go as far as to say that the discourse on digital scholarship proper is accompanied by a meta-discourse on innovations in technological instruments and their epistemic implications. Partly promotional, partly academic, this meta-discourse always refracts our perception of digital scholarship, albeit serving potentially different purposes.

A popular rhetorical device that the more enthusiastic advocates of digital infrastructure have regularly mobilized to promote their vision is the comparison between digital technology and the printing press. In his keynote speech at the World Social Science Forum 2013 for example, media theorist Derrick de Kerckhove argued that the advent of the printing press triggered a cognitive and scientific revolution, and he drew a parallel between these historical developments and the ways in which digital

⁶ An alternative metaphor compatible with my perspective is that of infrastructure as following a historical drift (Ciborra & Hanseth, 2000).

technology currently changes knowledge production in the social sciences and humanities. Such comparisons resonate with a venerable academic tradition (often explicitly referenced) that credits the printing press itself with a causal role in promoting the scientific revolution of the 17th century. The scholarly work that has most fully developed this idea is Elizabeth Eisenstein's *The Printing Press as an Agent of Change* (1979). Eisenstein argues in impressive detail that the printing press was instrumental in the separation between experimental philosophy and deductive traditions of thought. For the first time in (Western) history, the printing press allowed to circulate texts in an authorized, stable shape, thus overcoming the susceptibility of manuscripts to errors from translation and reproduction. The possibility to exchange standardized information in turn enabled scholars to engage in comparative empirical work on a large scale. Eisenstein's work is in many ways shaped by the influential theorizing of Marshall McLuhan, who ascribes media technologies a causal effect on public discourse, the organization of society, and the epistemic principles of science. According to McLuhan's popular bottomline, "the medium is the message".

The function of comparisons such as de Kerckhove's has been extensively studied by the sociology of expectations (van Lente, 1993; Brown & Michael, 2003; Borup et al., 2006). The latter has shown that the very hyperbole that often surrounds new undertakings in science and technology correlates to the underlying uncertainty of these visions. Precisely because individual actors wish to change the status quo in some consequential way, they need to make bold promises, thus mobilizing resources and creating protected niches for nascent practices. Many advocates of digital scholarship and e-science have pursued this strategy in order to mobilize resources and make possible targeted interventions in the form of digital research projects and tool building initiatives. Inevitably, however, the use of new research tools – even if they are immediately adopted by researchers in the context of a project – implies a reshuffling of the socio-material setup of extant scholarly work processes, thus creating an inevitable amount of tension with the complex and often invisible ties that connect local practices to the institutional and disciplinary history of the humanities. While seasoned practitioners will tend to be very careful about the strategic promises they make to funders and policy makers (see for example Unsworth, 2007), the tremendous current interest in digital scholarship also brings into play actors with little experience in actually developing and implementing new research tools in a humanities context. Hype often does create the economic

and political preconditions for such large-scale undertakings, but by emphasizing the role of inherent technological potential in effectuating change, it also fails to create awareness or even provide a language for addressing the issues that arise when promises turn into requirements (van Lente, 2000). A good illustration is Project Bamboo, a prestigious US project that is now widely considered an example for how *not* to go about the development of digital infrastructure (Dombrowski, 2014). The goal of Project Bamboo was to create a comprehensive set of digital tools for a large bandwidth of scholarly purposes over the course of 7 to 10 years. Renowned digital scholars criticized Project Bamboo from early on for concentrating significant conceptual authority in the hands of a small group of funding officers, computer scientists, and scholars (Ramsay, 2013). According to these observers, lack of sensitivity to actual scholarly needs combined with its exaggerated ambition led to a disconnect between designers and users, as well as bogging down the development process in lengthy negotiations. Project Bamboo eventually failed to deliver a workable proof of concept at the end of the initial funding period, not to mention the longer term goal of a widely used infrastructure (Dombrowski, 2014; Boast, 2009). A recent report commissioned by the British Research Information Network similarly indicates a conceptual disconnect between technological promises and actual disciplinary needs. The authors conclude that while scholars do have a strong interest in tools that they perceive to meaningfully support their respective practices, they are equally disinterested in applications that primarily seem to result from the research agenda of computer scientists (Bulger et al., 2011).

Here it is useful to highlight that Eisenstein's view of the historical trajectory of the printing press – while still serving as a blueprint for the promotional meta-discourse about digital scholarship – is generally considered to be outdated by more recent generations of scholars of science and technology. In his influential critique of Eisenstein's work, Adrian Johns (1998; 2002) summarizes the distinctive features of this conceptualization of technology: firstly, particular tools are ascribed an inherent potential that determines their use. Secondly, this means that once invented, innovative technologies such as the printing press exert a revolutionary force that will bring about potentially fundamental change in a society. Johns dismisses this view as reductive, and he argues that the book as an artifact was constructed in a process of social shaping. Rather than following the unfolding of some revolutionary potential inherent to technology, it was due to the confluence of various actor interests that the book as we know it today

became stabilized, i.e. associated with particular material format that is invariant across time and space. To support this argument, Johns sheds light on the significant efforts actors had to make to achieve such standardization, and in particular also the persistent attempts to subvert it, for example through piracy and illegitimate editions (see also Johns, 2009).

Theoretically, Johns' critique is heavily informed by research in Science and Technology Studies (STS), a field whose intellectual outlook makes it a highly relevant contributor to the current meta-discourse on the relation between technological instruments and the research process.⁷ Historically positioning itself as an academic contender against critical rationalism and Mertonian sociology of science, STS has a rich tradition of problematizing the conceptualization of technology as an autonomous agent that characterizes some current expectations towards digital infrastructure. A core theoretical development in STS scholarship in the 80s in fact was the extension of constructivist views from scientific knowledge to technology (Bijker & Pinch, 1984; Bijker, Hughes & Pinch, 1987). According to this view, technology does not in any straightforward sense determine the practices of its users, but is also itself formed through application in specific contexts. Design here is not exclusively seen as taking place in the offices of engineers and technologists, but as a process that extends to the sites in which technology is being put to use (Oudshoorn & Pinch, 2003). This idea is condensed in the notion of mutual shaping (see Williams & Edge, 1996). Moreover, STS has a longstanding tradition of conceptualizing knowledge production as a situated socio-material practice (Knorr Cetina, 1981; Knorr Cetina, 1999, Latour & Woolgar, 1979; Latour, 1987) that is tied to historically developing, institutionally anchored disciplines (Whitley, 2000; Becher & Trowler, 2001). STS typically pictures tools, conceptual frameworks, and social order in a site to form particular configurations, thus making possible the generation of specific forms of knowledge. A change in the technological base of this configuration will affect, and be affected, by its epistemic and social features (Galison, 1997). Given the complex intertwining of these elements, and their specificity to historical and geographical context, no such change is likely to follow the pattern of sweeping revolution. A range of different actors have applied the constructivist lens to look at

7 Johns' monograph is based on his PhD research, which was supervised by the influential STS scholar Simon Schaffer. Moreover, Johns explicitly points out his intellectual debt to the equally eminent Steven Shapin, in particular the book *A Social History of Truth* (Shapin, 1994).

current developments in digital scholarship. On the one hand, a relatively small number of STS scholars (Wouters & Beaulieu, 2006; Beaulieu & Wouters, 2009; Dutton & Jeffreys, 2010; Fry & Schroeder, 2010; Meyer & Schroeder, 2010; Schroeder, 2008; Schroeder & Meyer, 2013; The Virtual Knowledge Studio, 2008; Wouters et al., 2013). One explanation for this valuable, though overall limited interest could be that STS has historically had a focus on the natural sciences, in order to show that constructivist accounts can be applied to 'hard' forms of knowledge production like particle physics or molecular biology. On the other hand, theoretical concepts from STS have recently been taken up by actors who have a more immediate stake in current translation activities. Digital scholars in the US have used STS knowledge to stress the grounding of technology use in local practices (ACLS, 2006; Unsworth, 2007), thus promoting a vision of infrastructure as an emergent property of ongoing digital scholarship. Many European policy makers and infrastructure project leaders have in turn switched to frame the goals of respective funding frameworks in a terminology of mutual shaping. A strategic document published by the European Science Foundation for example argues that the development of digital infrastructure must involve prospective scholarly users from early on, if the technology is actually to be adopted on a wide basis (ESFRI, 2011). Similarly, Anderson, Blanke & Dunn (2010) outline how the European infrastructure initiative DARIAH is informed by the concepts of mutual shaping and trading zones (Galison, 1997). Anderson, Blanke & Dunn suggest that both a techno-deterministic view in which new tools inevitably bring about new practices, as well as a radical constructivist view in which research practices are largely immune to technological stimuli, fall short. Instead, digital infrastructure should be conceptualized as a 'marketplace of services', from which scholars can adopt those tools that suit their needs, and in ways that individually make sense for them.

Naturally, such use of analytical concepts from STS should be seen with a critical sensibility as to its political function. The mere adoption of a terminology of mutual shaping does not tell us anything about whether and how the concept will inform the design process of digital research technology, or the way conflicts resulting in the implementation phase are resolved. The use of trading zones in infrastructure projects similarly requires close attention to the organizational and political context of respective initiatives. Trading zones can emerge from a relatively 'peaceful' encounter between different disciplinary cultures who work towards viable arrangements for all parties over time, or they may be the result of coercion

in which one set of practices simply supplants another one (Collins, Evans & Gorman, 2010). The very choice that something should become a trading zone, taken by one group of actors for another one, is itself an important expression of power. Framing infrastructure projects in the terminology of trading zones, then, does not necessarily guarantee a more democratic or context-sensitive way of creating technology, but may well serve a similar rhetorical purpose as older techno-deterministic accounts, namely that of creating political legitimacy for technological choices.

We are thus confronted with a somewhat paradoxical situation: STS terminology and ideas have diffused into policy contexts, where they are used for various political and intellectual purposes, while STS itself has devoted relatively little, proper attention to digital scholarship. What is therefore needed, I suggest, is empirical research and further theoretical reflection on the actual development and use of digital research technology by humanities scholars. This analysis should be reflexive with respect to the inevitable partiality of its underlying conceptual choices, and to the way social scientific insight may itself become a resource for actors. The following thesis is the outcome of my attempts to engage in exactly such research. The chapters are conceived as separate journal publications. They are held together, however, by the overarching theme of scholarship as a historically grown, institutionally embedded, and therefore inert phenomenon, which is currently being reinvented through the lens of the digital. My argument is that only those translations that are sensitive to the local manifestations of this inertia will lead to longer lasting innovations in the scholarly work process.

Infrastructural inertia and reflexive adaptation

A first assumption of this thesis is that tools have no essence that inherently determines their use. Instead, the function of individual research tools must be seen in the context of scholarship as a larger, historically developing infrastructure. Drawing on the work of Suzan Leigh Star, Karen Ruhleder, Geoffrey Bowker, and others (Star & Ruhleder, 1996; Bowker & Star, 2000; Hughes, 1983; Edwards, 2010), I here use the term infrastructure in a specific theoretical sense: it denotes the relational state that obtains when heterogeneous, but cooperative practices, for example in the academic labor ecology, achieve a state of smooth coordination.⁸ The conduct of scholarly

8 In the present chapter as well as in the remainder of the thesis, I have tried to distinguish

work in fact depends on the accomplishment of a large number of other tasks, ranging from administrative work and the maintenance of physical workspace to the provision of library and information services, to name but a few. Each of these tasks constitutes a practice in its own right, complete with specific conventions that must be mastered by new entrants, and which therefore also inform the larger whole in one way or another. An important interface between different task areas is provided by all sorts of standards and classifications, which are simultaneously material and cognitive. Think of the countless norms that are embodied in a tool such as a computer keyboard, and the way it shapes the act of writing a scholarly paper both as a physical act and as an intellectual operation. In the absence of a singular management structure, standards exert a subtle normative force that makes heterogeneous practices compatible. Infrastructure thus invisibly supports tasks, rather than having to be assembled or reinvented every time anew. As a side effect, infrastructure tends to be transparent to its acculturated users, precisely because it is reproduced through the work routines those actors engage in on a daily basis.

Infrastructure studies is usefully complemented by the concept of hinterlands as proposed by John Law (2004). This perspective similarly emphasizes the invisible constraints of historically grown research practices, albeit with more explicit attention to their implications for the specific forms of knowledge created. Hinterlands denote particular assemblages of material and symbolic elements that temporarily cohere in the methodological apparatus underlying disciplinary knowledge production. While this concept is in many ways compatible with Kuhn's paradigms, it puts more focus on the notion that established research practices also enact reality, rather than merely providing historically shifting possibilities for describing it. Law argues that instead of discovering facts 'out there', methods amplify certain realities out of a wide range of possibilities, thus foregrounding some elements while pushing others into invisibility. The economic metaphor of the hinterland is meant to express that some realities are easier to establish because they draw on standardized packages of material and semiotic relations (see Fujimura, 1987; 1992). Such packages

this specific theoretical meaning from the unrelated terms 'digital infrastructure' and 'cyberinfrastructure' through appropriate contextualization. For example, when discussing the development of digital infrastructure in Europe and the US, I provide enough description to make clear that I am referring to particular empirical phenomena, rather than the theoretical framework of Star & Ruhleder.

gradually develop through knowledge and practices that become widely acknowledged in a field, thus crystallizing into a relatively stable, taken-for-granted epistemic and praxeological framework. Examples of packages include established data formats in a given field, stylistic and argumentative conventions for communicating research findings, and implicit social protocols that order the interaction among disciplinary peers. For example, in the monograph-based scholarship of history and literary studies, narrative forms of knowledge are traditionally privileged. Historical events are primarily narrated, even when the author draws on quantitative empirical information. A piece of scholarship that is unconventional in its material or literary format - for example by presenting an algorithmic analysis of historical events, or by publishing findings in the format of a digital database - may be difficult to recognize as a valid disciplinary contribution by peers. Insofar as it can only partially build on the work of predecessors, it may require 'redoing' some foundational empirical or theoretical work, and thus end up being dangerously demanding in terms of resource and time investment. This aspect also highlights an important political dimension of the hinterlands perspective. Specific forms of humanistic knowledge here are seen not as the natural ideographic expression of underlying historical or social reality, but as the result of specific methodological choices constrained by various external factors.⁹

An important feature that distinguishes modern academic research from historical forms of knowledge production in fact is the formation of a disciplinary structure as well as the institutionalization of science and scholarship in the 19th century (Stichweh, 1984; Whitley, 2000). According to the traditional model of disciplinary organization, the dynamics of research are determined by mechanisms such as peer review, the circulation of influential publications, and the accumulation of intellectual reputation among colleagues. This disciplinary organization is entwined with institutional power, most importantly in terms of the control over resources

9 While strongly informed by Law's interest in actor-network theory, I would argue that the concept of hinterlands is not least meant as a reaction to the longstanding critique that actor-network theory is politically conservative in the sense of being too descriptive and malleable, thus allowing to see seamless networks where one actually is confronted with complex, yet difficult to discern structural conflicts (see for example Whittle & Spicer 2008). The focus on the unseen and structure-like that is implied by metaphor of the hinterlands has a tendency to highlight rigidity and tensions, rather than malleability. Such an analytical perspective, I suggest, creates a useful contrast to the often hyperbolic policy expectations towards the revolutionary potential of digital research tools.

and employment opportunities exercised by universities. A small but influential body of literature has provided detailed comparative accounts of the various disciplinary cultures that have emerged across the humanities and natural sciences over the last 200 years (Becher & Trowler, 2001; Whitley, 2000; Knorr Cetina, 1999). Particularly useful for my own research is the work of Richard Whitley (2000), who has introduced the analytical concepts of mutual dependence and task uncertainty to distinguish different fields of research on the basis of their relative degree of social and intellectual integration. The field of literary studies for example is characterized by a low degree of mutual dependence and a high degree of task certainty when compared to most natural sciences. Knowledge is circulated in monographs, a format that grants individual academics considerable analytical and stylistic freedom. Populated by proverbially 'lone scholars', there is a large variety of research goals and coexisting theoretical views. Knowledge production in fact is partly driven by productive disagreement between representatives of different theories, rather than by integration of individual knowledge contributions in a single dominant framework, as is the case in more highly integrated domains in the natural and quantitative social sciences. Different organizational features also go along with specific types of research instrumentation. Fields characterized by strong consensus on theoretical frameworks and data formats across sites tend towards uniform, often large-scale research instruments. Research here is typically organized as collaborative work process with clearly divided tasks, proceeding from the generation to the analysis of large amounts of data (Galison, 1997). Loosely integrated fields on the other hand are likely to operate with instruments that are more specific to local research contexts (Shrum, Genuth & Chompalov, 2007). At the same time, there are indications that the institutionalized mechanisms of disciplinary research organization have begun to undergo change (Whitley, Gläser & Engwall, 2010). A relatively recent development is the practice of evaluating research on the basis of formalized indicators. These indicators are not only used by research policy, but also by individual researchers and university administrators, with potentially significant effects on the inner workings of the disciplinary reputation economy (Espeland & Sauder, 2007; Martin & Whitley, 2010). The most important development for the present thesis certainly is the emergence of often large-scale, transnational funding frameworks for digital infrastructure, as well as new managerial structures that aim to coordinate research and tool development internationally. Such grants partially loosen the economic and disciplinary constraints on the epistemic choices that

researchers make in preparing knowledge contributions. Yet the managerial imperatives connected to these grants – for example the call to avoid redundant investment and to aim for utmost reusability of data and tools – also create new constraints that may not be congruent with established conventions, thus resulting in a tension between infrastructure funding frameworks and nationally based, disciplinary scholarship.

Through the combination of theoretical resources from infrastructure studies, the perspective of hinterlands and sociological theory, we can begin to outline a number of areas for research. For one, infrastructure as well as hinterlands picture knowledge production as sedimented socio-material practices, which in turn reproduce (or challenge) institutionally recognized definitions of 'proper' scholarship. The use of research tools is often part of a disciplinary curriculum, and the tools are conceptually bound up with the theoretical and methodological base of that field. Insofar as it is widely used in accordance with received notions of its meaning, established technology therefore has a tendency to become transparent to its users. Put differently, specific ways of using technology are encouraged by the institutional, conceptual, and organizational features of infrastructure. Hypothetical affordances of new instruments – perhaps built into them by computer scientists or software engineers operating under a very different set of constraints – in turn may be discouraged and perhaps not even recognizable to acculturated members of a field in the first place. At the same time, scholars may creatively adapt the tools in ways not anticipated by their designers. An important task therefore is to interrogate how the inertia of infrastructure manifests itself in the move to digital scholarship, and to analyze how this inertia shapes the embedding of new research tools in scholarly practice (Chapters 1 and 2).

Moreover, the perspective of scholarship as embedded in a larger infrastructure draws attention not only to the interaction of scholars with technology, but also to the many other task areas that enable this 'primary' research activity in the first place (Strauss & Star, 1999). In traditional modes of humanistic inquiry, the work of scholars has been enabled and constrained by the often invisible work of archivists, librarians, and bibliographers. Historians and literary scholars after all depend on another group of professionals who make sure that textual sources in archives and special collections are accessible and well curated, so that they can be referenced in academic monographs and papers. However, in many collaborative digital projects, the traditional boundaries between scholarly activity and support work are blurred – the various tasks necessary to create,

maintain, and expand a scholarly database for example cannot straightforwardly be divided into curation and research. Insofar as different forms of labor are subject to different reward systems, such shifting of boundaries seems to pose an interesting opportunity for research. At the same time, STS does not have a strong tradition of taking into account the economic dimensions of science. Some scholars (Vann & Bowker, 2001; The Virtual Knowledge Studio, 2008) have attributed this to the common STS approach of conceptualizing scientific work as practice, a perspective that – while meant to broaden Mertonian and Popperian views of science as a purely cognitive operation – also tends to downplay the material cost of research. The move to digital scholarship in the humanities, however, and the transformation of the academic labor ecology it has occasioned, provides a very good reason for studying how the exchange value of scholarly labor mediates its intellectual substance (The Virtual Knowledge Studio, 2008).

The current discourse on digital scholarship in fact strongly tends to emphasize the consequences of digital technology for intellectual work rather than for curation and data work. For example, it has become something of an informal requirement in funding proposals to promise that digital tools will scale up the empirical scope of research. This resonates well with the policy expectation towards a more data-driven, algorithmic form of humanities scholarship, but it tends to downplay the huge amounts of labor that will be necessary for digitizing sources, entering and harmonizing digital data and metadata, and providing sustained support to keep digital materials and applications usable in the long run. There is even a certain tendency in the policy discourse to associate 'digitization' initiatives with cost-cutting. Transforming collections and bibliographies into digital artifacts here is often connected to laying off staff for the maintenance of physical facilities (Baars et al., 2005; PLG GTA, 2013). Projects that primarily aim to hire new staff for large-scale digitization of print sources generally do not have very good chances of acquiring funds (personal communication). Over the past decade, we have witnessed a number of curious attempts to tackle the problem of data work. For example, we have seen recent collaborations between venerable academic institutions and Google. The latter has an interest in improving the attraction of its Google Books service, and therefore has invested significant amounts of money into the digitization of major university collections. However, the mark-up and metadata applied in these digitization efforts has been criticized for not living up to the specialized needs of scholarly inquiry (Duguid, 2007). Moreover, there has been a number of ambitious crowdsourcing projects, the

most publicized of which is probably Transcribe Bentham. The idea behind this initiative was to mobilize interested laypeople to digitize and mark up the complete writings of Jeremy Bentham, given that funding bodies are usually very reluctant to finance such work. Project staff have recently evaluated the success of the undertaking somewhat critically, however (Causer, Tonra & Wallace, 2012). Perhaps unsurprisingly, it has proved very difficult to mobilize a large enough number of volunteers and organize their transcription work in such a way as to attain a satisfying (and economically viable) data quality. Large-scale algorithmic knowledge claims about the works of Jeremy Bentham will therefore remain impossible in the foreseeable future. Under the radar of most casual observers, it seems, digital scholarship is importantly shaped by allocation of funds for what is often seen as mundane data work. An important question therefore is: How do actors construct forms of labor as 'scholarly', 'technical', or 'support activities', and how does the distribution of such labor make possible certain forms of knowledge, but not others (Chapters 1 and 2)?

Another area for research is the way that disciplinarity and situatedness of specific research practices relate to the construction and use of digital research technology. The concept of digital infrastructure, as well as most tools for data-intensive, algorithmic research, are often claimed to be of universal benefit to all fields of research. In reality, these technologies are often informed by the particular requirements of certain natural sciences, thus confronting its prospective scholarly users with analytical possibilities that they do not necessarily have an existing disciplinary need for (Wouters, & Beaulieu, 2006). Previous research has already stressed how the adoption of given tools depends on disciplinary traditions (Borgman, 2007; Collins, Bulger & Meyer, 2012; Fry & Talja, 2007; Fry & Schroeder, 2010). An observed pattern has been that disciplines such as linguistics, which has a strong tradition of computational empirical research and a relatively high degree of internal integration, are quick to take up certain tools, say, for the analysis of large-scale corpora of textual data. On the other hand, disciplines with more internally divergent research priorities and less mutual dependence among individual scholars have found to be reluctant in their uptake of the same tools. There is a number of possible ways in which this could play out in the future. For one, tools could be adopted one-sidedly by fields with established data-intensive traditions. Alternatively, a process of mutual shaping could transform the more hermeneutic fields in such a way as to create a need for such tools. Another hypothesis is that we will see more efforts by scholars to tailor technologies to their specific requirements

and intellectual preferences, rather than adopting applications modeled on particle physics or computer science. An important question therefore continues to be: how does disciplinarity shape the use of digital research tools, and how does the use of these tools shape disciplinarity (Chapters 1, 2 and 3)? Directly related to this is the question of interdisciplinarity. A characteristic expectation towards digitally mediated research – both in the sciences and the humanities – is that it will create new possibilities for collaboration. Digital infrastructure projects in particular promise to facilitate the sharing of analytical tools and data across disciplines and geographical distances (Atkins et al., 2003; ACLS, 2006; Hey & Trefethen, 2005). However, Edwards et al. (2011) have cautioned that greater interaction among researchers will inevitably create 'science friction', i.e. difficulties in communication that arise due to diverging ways of framing research questions, appropriate methods for answering them, as well as differences in handling data. We can reasonably assume that the amount of friction – and thus the additional work involved in bringing collaborative research to closure – will at least partly depend on how strongly the interacting disciplines differ in terms of their characteristic epistemic and organizational features. What does this mean for interdisciplinary collaboration in digital scholarship and the development of digital research tools for the humanities? How do scholars, typically acculturated in hermeneutic traditions such as close reading and thick description, work out a collaborative arrangement with computer scientists and software developers? How do they resolve tensions between very different epistemic frameworks, yet without giving up their commitment to their respective hinterlands (Chapter 3)?

Several aspects of my conceptual framework highlight how the dynamics of digital scholarship are shaped by various forms of constraints. This should not lead us to neglect the inherent underdetermination of new scholarly tools as an important area for investigation, however. STS has rightfully pointed out that while technology often comes with specific scripts built into it (Akrich, 1992; Oudshoorn & Pinch, 2003), i.e. implicitly or explicitly formulated aids for how to 'read' and use a technological artifact, there is nothing in a tool that would fully determine how it is eventually deployed in practice. Similarly, while infrastructural inertia and disciplinary logic in many ways constrain digital scholarship, the development of a field of research is not fully determined by its history. How, then, do actors come to select a specific use of new technology over another one, and how are hinterlands restructured as new tools are embedded in scholarly practices? I

suggest that the development of infrastructure can at least partly be understood as driven by an intentional reflexive agency of scholars. Individual practitioners of digital scholarship typically also try to shape their academic work environment according to their specific visions and normative interests. This often entails going against the grain of established infrastructural routines, thus requiring an investigation of the process by which scholars 'untie' the standardized material and symbolic packages that constitute a given hinterland (Law, 2004; Fujimura, 1987; 1992). Reflexivity in discourse and practice allows to reimagine scholarship in the light of potentialities, and thus fulfills an evolutionary functionary in the development of scholarly infrastructure. Different forms of reflexivity likely will open up different paths for development, however, thus making it also a site of controversy in which different actor interests clash (Chapters 3 and 4).

A last aspect worth addressing in more detail is the relation between digital scholarship as practiced in individual projects and the various, overarching infrastructure initiatives that are concurrently undertaken (Atkins et al., 2003; ACLS, 2006; ESFRI, 2010). In most Western postwar science systems, choices about the development of particular research tools and facilities used to be reserved for disciplinary elites, i.e. researchers who had acquired significant reputation among their peers (Whitley, 2000). Relations between researchers on the one hand, and funding bodies and policy makers on the other, were based on the relatively stable agreement that science would produce a continuous stream of useful knowledge and technology if given a certain discretion in organizing its activities (Mirowski & Sent, 2008). Current digital infrastructure initiatives, however, take place against the background of changing relations between those actor groups (Nowotny, Scott & Gibbons, 2001; Etzkowitz & Leydesdorff, 2000). Policy and funders now often take a proactive role in scientific agenda setting, while university block funding, an important economic basis for disciplinary self-governance, is being reduced (Mirowski & Sent, 2008). Current infrastructure initiatives play a particular role in this reconfiguration process. Usually framed as a foundation for future economic and scientific success of a country or region, they connect researchers, funders, and policies in strategic alliances (Barjak et al., 2013). Not much published research has addressed how intellectual and political interests of different actor groups are bound up in the development of digital infrastructure, and in what ways such initiatives differ between countries. However, this is important empirical knowledge for an STS analysis of the sort I propose, because

specific policies of funding and coordinating tool development will also create distinct conditions for individual projects in digital scholarship. My final research question proposes a comparative analysis of this interaction: What strategic considerations underlie current infrastructure initiatives in Europe and the US, and how do they affect the organization of tool development for digitally mediated scholarship (Chapter 5)?

Summary of the research questions

1. What does it mean to think of infrastructure as inert, and how does this inertia shape the embedding of new research tools in scholarly practice?
2. How do actors construct forms of labor as 'scholarly', 'technical', or 'support activities', and how does the distribution of labor make possible certain forms of knowledge, but not others?
3. How does disciplinarity shape the use of digital research tools, and how does the use of these tools shape disciplinarity?
4. What is the reflexive agency of scholars in the embedding of new tools into their infrastructural work setting?
5. How is infrastructure conceptualized differently across countries, and what role do such conceptualizations play in organizing infrastructure development 'on the ground'?

Methodology: the case study and the article-based PhD dissertation

While each of the following chapters contains a separate methods section, a few words are in order to outline and reflect on the common methodological principles that underlie this thesis. The specific form of knowledge I have produced can perhaps best be described in a reflection on the intertwinement of two changing organizational aspects of academic scholarship: the move from the monograph-based dissertation to an article-based model, and the changing socio-material conditions that accompany the adoption of digital research technology in the humanities.

This thesis follows the model of an article-based thesis, which is becoming an increasingly popular modality of gaining a doctorate in the Netherlands and a number of other European countries, as well as Australia and Canada (Park, 2005; Powel & Green, 2007; Kamler, 2008). An important context for this development is a loosely concerted international effort by academic institutions, policy makers, and researchers to make postgraduate work more 'accountable' and 'transparent' (Park, 2005; Bartelse, Oost &

Sonneveld, 2007). The traditional monograph model dominant in the humanities and qualitative social science entails that the PhD candidate is largely invisible to administrators for a number of years – to put it casually, students would disappear in field sites and libraries for several years, and then hopefully emerge with a scholarly book in their hands. The switch to the article-based thesis on the other hand is many countries related to a contractual stipulation of supervisory obligations (Robins & Kanowski, 2008), as well as the spread of graduate schools that add an educational component to the research process (Bartelse, Oost & Sonneveld, 2007; Sonneveld, 2010). At the same time, there is still a degree of legal uncertainty surrounding the article-based thesis. In the Netherlands for example, no single university offers binding rules for the required amount of papers, for how many papers must be published at the time of submission, or in what type of journals (see Leiden University, 2008; University of Amsterdam, 2014). There is merely the informal recommendation that the thesis should consist of four papers in total with at least one accepted for publication (Vrije Universiteit Amsterdam, n.d.). Of course, the new PhD model also resonates with a parallel process of accelerating the 'throughput' of academic knowledge production, accompanied by the increasing importance of publication-based methods of evaluation. The intellectual and stylistic freedom implied by the monograph makes it particularly difficult for non-disciplinary evaluators to assess its intellectual value, while journal impact factors facilitate relatively simple (though frequently dubious) quality judgments. Critics in fact have portrayed the article-based thesis as a concession to managerial sensibilities that produces 'audit-ready PhDs' as well as a form of 'precocious professionalism' (Park, 2005), thus suggesting a certain leveling of the intellectual quality of doctoral work. As I know from conversations with fellow graduate students from the national graduate school WTMC, the article-based thesis is frowned upon by some faculty in some universities, thus putting graduate students in the uncomfortable situation of having to side with either the defenders of the monograph-model, or those that embrace the article-based dissertation.

I would argue that the new modalities do not produce inherently less valuable knowledge, but rather entail a different way of structuring doctoral work intellectually and in terms of everyday work routines. I personally found the prospect of organizing my work around individually published milestones more appealing than having to work on one single big chunk, with less manifest possibilities for assessing progress. The other reason for opting for individual articles was that I did not see the point of

sticking to the monograph format when research evaluation increasingly values peer-reviewed articles. This also constitutes a specific choice in terms of the prospective audiences, however. A (published) monograph might potentially have reached a wider, non-specialist group of readers interested in digital scholarship, while articles are more likely to be read by social scientists and scholars with access to a digital university library. On the other hand, the article format also means that my arguments feed back to the actors I study in a formal, but quicker way than if I had opted for a monograph. Before discussing this latter implication in more detail, it is necessary to address the specific epistemic constraints that come with an article-based thesis. Rather than a single unified narrative, an article-based thesis implies a collection of several independent publications, which nevertheless amount to a larger argument in their totality. Given the often excruciating duration of peer review, at least two articles should be finished well ahead of the last year before graduation. This obviates the possibility to modify an argument after it has been published, while a monograph in principle allows to continuously develop the argument in light of the most recent insights one develops about the subject. At the same time, when working on individual articles, one often has to respect the wishes of the journal editors and reviewers, thus bringing into play the judgment of a number of additional scholars who may not always be from the same discipline as the PhD candidate, the supervisors, or the PhD committee. An article-based thesis thus trades off speed of circulation for internal coherence of a monograph. Perhaps the most important constraint of the article-based thesis in STS, however, is that it will tend to further consolidate the case study approach that is dominant in the field. In line with an established tradition in STS, research must be simultaneously based on theoretical reflection and empirical field work, most often in the form of ethnography, participant observation, and interviews. Analyses of individual 'cases' usually provide just the right amount of empirical material for an article, which in turn is becoming a more and more important complement to the monograph as the dominant form of scholarly output in STS.

Of course, rather than picturing the case study as a lucky fit for the genre conventions of the scholarly article, one could also consider it as an artificial way of segmenting reality that actually results from the constraints of academic social science. Much recent writing on STS methodology in fact has critically reflected on the limitations of the case study approach (Shrum, Genuth & Chompalov, 2007; Wyatt & Balmer, 2007; Law, 2004; Hine, 2007; Beaulieu, Scharnhorst & Wouters, 2007). As Shrum, Genuth & Chompalov

(2007) argue, the notion of a case study implies that what is under investigation is a meaningful unit of analysis that simultaneously captures a representative empirical element of a larger phenomenon. This assumption has historically fulfilled the function of legitimizing the knowledge produced by the case-studying researcher, who could thereby claim empirical representativity and authoritative insight about the phenomena he or she studied. At the same time, STS has a long tradition of methodological reflexivity. The explicitly relativist orientation of much foundational STS research with respect to the knowledge claims of natural scientists (Bloor, 1976; Collins, 1985) has early on raised the question as to the status of STS knowledge itself. On what grounds can social scientists claim a form of epistemic validity when their main argument is that knowledge is always socially constructed (Ashmore, 1989)? Since then, method in STS has widely come to be seen as generative of reality, rather than providing a neutral way of describing it (Law, 2004). From this perspective, uncritical use of the case study threatens to reify both the level of an individual case as the natural unit of analysis, and that of a larger culture or system of which the individual case allegedly constitutes a part, and which in turn must be specified by a number of shared features (e.g., organizational characteristics, tools used, conceptual elements) (Beaulieu, Scharnhorst & Wouters, 2007). Moreover, some scholars (Hine, 2007; Mol, 2002) have criticized the traditional understanding of the case study for its tendency to associate the individual case with the local, and the level of a discipline or field with the global, supra-local. The latter metaphors imply a potentially misleading spatiality that will tend to undermine how, say, what happens in the context of an individual project is simultaneously affecting and being affected by an academic field as such (Beaulieu, Scharnhorst & Wouters, 2007; Beaulieu & Simakova, 2006; Beaulieu, 2010; Jensen, 2007). An important influence for this type of critique has been non-dualistic theorizing by authors at the intersection of STS and anthropology (Strathern, 1991; Verran, 2001; Tsing, 2005; Mol, 2002; Law, 2004). The central argument of this literature is that dichotomies such as local/global, micro/macro, and field/laboratory cannot be used as stable concepts on which to base methods, but must themselves be analyzed as achievements of actors.

This methodological reflection has been additionally stimulated by the proliferation of ICT and the need to adapt existing theories to the specificities of digitally mediated research. While not inherently more complex than older modes of knowledge production, the development of digital infrastructure does go along with an epistemic, material, and

economic reorganization of research. As I have variously mentioned, a widely shared expectation is that the spread of digital instrumentation will facilitate collaborative relations between researchers across individual sites and disciplines, for example through the reuse of large datasets and networked tools for analysis. This suggests that individual epistemic artifacts will travel a lot more than was common in the past. Several scholars in STS and related fields such as Computer Supported Cooperative Work (CSCW) (Beaulieu, Scharnhorst & Wouters, 2007; Hine, 2007; Williams & Pollock, 2012) have therefore called for replacing a methodological focus on the interaction between actors and technology in isolated sites, and under the assumption of stable dichotomies of micro/macro, with a multi-sited ethnography (Marcus, 1995). The goal here is to study for example the mutual shaping of practices and technologies in use (Pipek & Wulf, 2009), as well as how seemingly foundational dichotomies are constructed and performed by actors. This also includes the ambition to trace the historical development of infrastructure over extended periods and from different viewpoints. Infrastructure may involve multi-dimensional temporalities specific to individual elements (e.g. the temporal logic of scientific careers vs. the lifetime of a given software package), and thus give rise to complex dynamics that become visible only through simultaneous attention to short and long-term events (Ribes & Lee, 2010; Ribes & Finholt, 2009). Beaulieu & Simakova (2006) moreover have proposed to take seriously the topology of the network, for example by studying how hyperlinks hook up different contexts in ways that transcend physical and intangible field boundaries. While few scholars would deny that it is desirable to extend the focus of ethnographic work in both time and space, Jensen & Winthereik (2013) have again cautioned against an empiricist tendency among practitioners of multi-sited ethnography themselves. Especially in the field of CSCW (e.g., Pollock & Williams, 2010), they argue, there is often an assumption that infrastructure can be strategically charted beforehand, with the expectation that carefully aggregated case studies can reach a degree of saturation over time and will add up to a comprehensive empirical picture if only enough empirical work is conducted.

By and large, however, STS advocates of multi-sited ethnography seek to establish methodological legitimacy not through expansive empirical coverage (i.e., through distributed and longer fieldwork sessions), but rather through intensity of their ethnographic interaction with infrastructure. The underlying theoretical assumption is that an essential distinction between the activities of actors and analysts cannot be drawn, since both engage in

mutual translation activities (Zuiderent-Jerak & Jensen, 2007; Zuiderent-Jerak, 2007; Vikkelsø, 2007). Thus, actors enroll other people and objects into networks, but analysts do the same when they collect empirical material and distill it into papers. In this perspective, it is no longer possible to claim that social scientists – after having 'covered' a preexisting fields through enough representative case studies – have straightforwardly superior, objective insight that they can for example use to advise policy. Rather, social scientific interventions are seen as implicated in partly unpredictable dynamics of alliance, betrayal, and negotiation with actors, with the latter pursuing often incommensurable normative interests as well as incommensurable ways of framing relevant issues. Zuiderent-Jerak & Jensen (2007) therefore argue for a social scientific 'ethics of specificity', i.e. the attempt to contribute to the explicit framing and resolution of carefully studied, situated conflicts. Hine (2007) suggests that such an approach can also provide a new means of making social scientific research relevant. Rather than framing the timeliness or adequacy of research in absolute terms, she suggests that social science is relevant if it creates meaningful resonances with actors in specific contexts, e.g. by meaningfully framing problems that in turn feed back into the translation work of actors. A number of researchers has moreover proposed to use the isomorphic relation between the translation activities of STS researchers and the actors they study as a methodological device. Jensen & Winthereik (2013) for example use their own experiences in doing fieldwork as an empirical instance of how infrastructure develops – here, the need to make certain connections with actors, to enter specific kinds of partnerships in order to get access to information, is not considered a practical nuisance, but as an opportunity for learning about the nature of infrastructure.¹⁰

In approaching my own empirical work, I have tried to reconcile a case study approach with several key aspects of the methodological discussions rehearsed in the above. For one, I have tried to engage in multi-sited ethnographic work that covers a number of different empirical

10 There are two reasons why such an approach should be applied with caution. First, its usefulness will depend very much on how detailed the resulting empirical accounts are. Given its rather descriptive character, uncritical use of actor-network theory could lead to a superficial portrayal of translation processes, without providing a sufficiently complex account of underlying structural constraints (e.g., of historically grown disciplines, technologies, institutions). Second, the method of emulating the translation behavior of actors should not be reified in its own right, perhaps under the assumption that it captures the *actual* reality of infrastructure development.

phenomena, yet without aiming for data saturation in an empiricist fashion. Moreover I have sought to be attentive to how categories such as 'discipline', 'field' and 'project' are not stable entities, but are themselves performed and subject to ongoing translation activities by various actors (including myself). The first three chapters can be grouped together in that they are based on the interrogation of a specific project (Chapters 2 and 3) or controversy (Chapter 1) within the ambit of digital humanities. In the last two chapters, I define more expansive research objects, namely the role of reflexivity in the discourse of digital humanists (Chapter 4), as well as the development of digital infrastructure in the US and Europe (Chapter 5). A useful methodological strategy in analyzing these different cases was to focus on the very tensions that arise as actors try to reconfigure the scholarly knowledge machine. For example, a characteristic of digital scholarship is that it is often practiced in collaborative projects, whereas knowledge production in the humanities is traditionally organized around the single-author, scholarly monograph as the predominant format. Moreover, different actor groups frequently try to combine digital scholarship with a strategic agenda, but often in ways that are informed by rather specific normative interests. In most of the following chapters, the organizational, epistemic, and institutional tensions that follow from these competing translation activities process appear center stage in the analysis.

In Chapter 1, I study the controversy around the decision of the Royal Netherlands Academy of Arts and Sciences to cease publishing the national bibliography for Dutch Studies in print, and to instead transform it into a digital database with a new set of functionalities and a reduced budget. Many practitioners of Dutch Studies perceived this as a threat to their field, thus prompting them to publicly insist on the importance of keeping the bibliography in its original form. This debate is not of the same type as investigated in older STS research in controversy studies, which focused on scientific arguments about whether or not a particular experiment has been successfully replicated, or what constitutes definitive empirical evidence for a given knowledge claim (Collins, 1985; Nelkin, 1995). Rather, the controversy around the bibliography is a clash between different ways of defining an area of scholarly inquiry, occasioned by an overarching discourse of the 'encounter' between the humanities and digital technology. My account of these discussions balances the presupposition of certain units of analysis (for example that of research practice and discipline) with a sensibility towards the way actors themselves leverage and contest such boundary-drawing.

In Chapter 2 I study how a group of 120 literary scholars from across Europe struggled to combine their university-based, disciplinary careers with participation in an international project in digital literary history. The goal of this initiative was to create a comprehensive empirical picture of 'forgotten' women writers through the collaborative use of an online database. Of particular analytical interest for the present thesis were so-called training school events in which the project participants learned how to use and ingest information into the database. These meetings were an occasion in which the established social and intellectual organization of literary history was challenged, for example insofar as theoretical concepts that are usually left to the discretion of individual scholars in the monograph-oriented model of research had to be operationalized in a consensual manner, so that the project as a whole could define shared analytical categories. Instead of simply enhancing established practices through the use of a database, the ensuing discussions brought to light numerous conflicts between the current infrastructural configuration of scholarly practice and the envisioned model of digital collaboration.

In Chapter 3 I study a project aiming to investigate regime shifts in contemporary Indonesian history through the algorithmic analysis of comprehensive corpora of digitized newspapers. A joint undertaking by scholars of Indonesian Studies, networks researchers, and computer scientists, it provided a good opportunity to study the relation between tool development and disciplinarity. More specifically, my analytical focus is on how the participants tried to devise a shared project workflow that allows for interdisciplinary collaboration, yet without overriding domain-specific epistemic conventions. This illustrates how 'the digital humanities project' is not some readily defined organizational entity that scholars simply 'join'. Instead, projects constitute a distinct new format of knowledge production that emerges from the reflexive attempt to balance the participants' diverging disciplinary commitments and career interests.

In the last two chapters, the methodological insight that the activities of STS researchers and the actors they study are essentially isomorphic has actually provided a foundational conceptual inspiration. In Chapter 4 I analyze how digital scholars engage in a reflexive discourse on the conditions of their research, with the aim of changing how contributions to scholarly knowledge are produced and associated with each other. Here I make the point that the circulation of reflexive arguments by digital scholars is not essentially different from the 'deconstruction' or 'inversion' of scientific practice as performed by STS scholars (e.g., Bowker & Star, 2000) – reflexive

representations are attempts to untie existing 'standardized packages' of socio-material activity (Fujimura, 1987; 1992), thus potentially changing the very structure of 'the field' over time.

Chapter 5 compares European and US approaches to developing digital infrastructure. Here I take an empirical look at various infrastructure projects and the policy discourse surrounding them. Different visions of infrastructure, I argue, can also help establish paradigmatic kinds of logic in how actors think about 'the field'. Once instantiated in funding frameworks and managerial structures, they tend to facilitate for example certain judgments about the relative similarity/difference of individual digital research tools.

In the two case studies that involved ethnographic work, I have tried to use my presence as an ethnographer as a methodological device, rather than treating it as an epistemic contamination of the field. An important aspect in getting access to both projects was the intellectual reputation and visibility of an institution I was formerly affiliated with, namely the Virtual Knowledge Studio for the Humanities and Social Sciences (VKS), which until its dissolution in 2011 was a very active player in digital scholarship in the Netherlands (The Virtual Knowledge Studio, 2008). Using my VKS relations to make contact with the project leaders, I introduced myself as an aspiring STS researcher, thus emphasizing my disciplinary expertise in theorizing and practically moderating the implementation of digital research tools in the humanities. In this sense, I drew advantage from the intellectual capital accumulated by previous generations of STS researchers when positioning myself as a participant observer. This does not mean that I had full control over how I was perceived by different actors within the projects. Sometimes, my work was perceived as a sort of requirements engineering research that would make implicit aspects of scholarly practice visible. At other times, I was seen more as a project therapist who drags suppressed group issues out into the open. Not least, project participants used my interest as a means of promoting their work to funding bodies and peers, according to the logic: 'we even managed to attract the attention of an STS researcher!' These experiences have informed my analysis insofar as they sharpened my awareness for the manifold forms of articulation work necessary to bring unconventional forms of scholarship to closure, both among the participants of a project and between the project and external actors such as funding bodies and evaluators (Fujimura, 1987; 1992).

Here it is worth noting that the article-based PhD format conditioned the interaction between my own knowledge and that produced

by the actors I studied in a rather specific way. For example, during my fieldwork in the above mentioned project in literary history (Chapter 2), I circulated a well-developed draft of my argument on the simultaneously technical and intellectual dimensions of datawork about two years into the project. The relatively formal character of the document - I distributed it with an explicit announcement that I was planning to submit to a peer-reviewed STS journal – arguably contributed to the attention that the participants paid to my findings. Had I been working on a monograph, they might have received my findings only in the more ephemeral and less 'weighty' form of a presentation at a project conference, or at best through a very early draft of a prospective book chapter that would be submitted only a few years later. The specific rhythm and format of an article-based thesis thus also affected how my own research acquired agency within the projects I studied. Not least, my peer-reviewed articles have become part of the way both projects present themselves to their funders, in the sense that they are listed as 'output' in the concluding evaluation reports.

Sometimes, my arguments were also read as a critique of managerial decisions or positions adopted by individual actors in the two projects. My strategy in maneuvering such situations was to be explicit about the partiality implied by my theoretical framework. Against the conceptual backdrop of infrastructure studies, the various kinds of friction that occur in the current institutional and praxeological re-organization of scholarship appear as a result of structural conflicts – conflicting career demands (do what is necessary to run a database project vs. do what is necessary to become a full professor in a university department), conflicting ways of making knowledge claims in different fields (algorithmic claims in network research vs. narrated, hermeneutic arguments in Indonesian Studies), and different disciplinary ways of performing epistemic concepts such as data (data as a highly standardized entity vs. data as highly specific to individual practices). Had I chosen a different conceptual approach, say, theories drawn from usability engineering or management-oriented anthropology, I might have explained these tensions as a result of poorly designed interfaces (Santos & Frankenberg-Garcia, 2007) or failure to create shared repertoires of communication between project participants (see Contu & Wilmott, 2003). In this sense, my research also co-produces the overarching theme that it professes to elaborate, namely the notion that digital scholarship will only be successful if it is developed with a reflexive sensibility to the evolution of the socio-material infrastructure that constitute the humanities. I would maintain, however, that this approach is a useful second step after the more

hyperbolic claims that are initially necessary to mobilize funding and political will for digital scholarship, as well as a useful complement to perspectives such as usability engineering. My analysis provides a context-sensitive means of framing the inevitable conflicts that arise when researchers begin to experiment with new forms of knowledge production. This makes the conflicts amenable to discussion, rather than preemptively dismissing them as expressions of intellectual conservatism or lack of collaborative spirit.

Table 1: Chapter Overview

	Pub- lished	Title	Co- author	Journal	Methods
1	2010	E-research and methodological innovation in Dutch Studies	Paul Wouters	<i>First Monday</i> 15(9)	Semi-structured interviews, document analysis
2	2014	Scholarly labor and digital collaboration in literary studies	-	<i>Social Epistemology</i> 29(2), pp. 207-233.	Participant observation, semi-structured interviews, document analysis
3	2014	Decomposition as practice and process: creating boundary objects in computational humanities	-	<i>Interdisciplinary Science Reviews</i> 39(2), pp. 143-161.	Participant observation, semi-structured interviews, document analysis
4	2014	Infrastructural Inversion as a generative resource in digital scholarship	-	<i>Science as Culture</i> 24(1), pp. 1-23.	Document analysis
5	-	Digital infrastructure in the humanities: reconfiguring the organization of scholarly tool development.	-	Under review at <i>Computer Supported Cooperative Work</i>	Semi-structured interviews, document analysis