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Abstract

We present and discuss a historical reconstruction of the development of a Microsoft SharePoint eInfrastructure in NorthOil (2003 – 2008). The eInfrastructure was to support strategically emphasized work processes and open up a richer context of decision-making around production optimization. Specifically, the new eInfrastructure was to make it more convenient to trace decisions historically and across disciplinary and geographical boundaries – a need driven in part by post-Enron requirements for more elaborate and systematic reporting to the stock exchange. The Microsoft-based SharePoint eInfrastructure was intended to "seamlessly" integrate the many different and distinct information systems holding relevant information on production optimization. A principal aim of our study is to analyze how, why, and who resisted this largely top-down eInfrastructure initiative. We analyze how local practices rely heavily on specialized, niche information systems that are patched together as an ongoing performance to achieve commensurability. These local practices, however, are not immune to change. We discuss the indications of a transformative amalgam of (elements of) the new eInfrastructure and (elements of) the existing, local practices.

Keywords: *integration, MS SharePoint, eInfrastructure, fragmentation*

* Paul Edwards, Geoffrey C. Bowker, Steven Jackson, and Robin Williams were the guest editors.

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Ecologies of e-Infrastructures

1. Introduction

E-Infrastructures, i.e., large-scale, inter-connected, and integrated communicative information systems, generate understandable enthusiasm as they apparently capitalize on the accumulated technological innovations and practical experiences gained through widespread use of Internet protocols and technologies (including the Web and Web 2.0), enterprise resource planning (ERP) systems and service oriented architecture (SOA) frameworks (Newcomer and Lomow, 2005). Visions of complete and comprehensive — seamless — integration of functionally, geographically, and technically distinct components and systems are hardly new (Chari and Seshadr, 2004; Hasselbring, 2000), but the maturing (thus, standardisation) of technology alongside significant practical experience substantiate current visions of working eInfrastructure (see e.g., special issue CSCW no. 2-3, vol. 15, 2006).

The empirical setting of our study of eInfrastructure is within NorthOil (a pseudonym). NorthOil is an oil and gas company with large amounts of digitally stored data, models, maps, and visual and numerical analyses of sub-surface resources covering the 34 countries in which it operates. Establishing working e-Infrastructures to serve NorthOil's 25,000 employees is an ongoing and longstanding effort for better efficiency and improved practices of knowledge sharing. Recently, eInfrastructure initiatives have been instrumental in addressing post-Enron regulations and practices for increased traceability, accountability, and transparency to government agencies, the public, the owners, and the stock market. To meet these standards for increased levels of documentation, it is vital to trace and document company decision processes over time. In this paper we explore how the trajectory of oil and gas well development is maintained and constructed *historically* across technological platforms and *disciplinary* and *geographically* boundaries.

Key to this, we argue, is the "patching together" of specialised, niche-oriented, partly competing and partly overlapping sources of information. Our empirical material draws on NorthOil's attempts to institutionalise a Microsoft-based SharePoint eInfrastructure (referred to in what follows as SharePoint) intended to integrate the many different information sources, formats, and presentations across functional, disciplinary, and geographical boundaries. Central to our story is the tension between implicit and explicit top-down demands for tighter integration embedded in the SharePoint eInfrastructure and how these unfold dynamically against the persistent, bottom-up reliance on niche systems and micro-practices of commensurability.

Many have pointed out the way overly ambitious eInfrastructure initiatives regularly fall short of expectations (Ciborra 2000; Hanseth et al. 2002; Star and Ruhlender 1996). Our analysis pursues the metaphor of an "ecology" borrowed from biology, as it evokes strong connotations of diversity, heterogeneity, variation, niches, and redundancy (Nardi and O'Day, 1999), thus underscoring a different connotation of the metaphor than that of Star and Ruhlender (1996), who address levels of learning. The reason for our focus is that it is helpful in explaining the empirically evident reluctance among NorthOil's users to comply with the "mono-cropping" (Power, 1997) vision embedded in the SharePoint effort, and the persistence of contrasting "poly-cropping" forms comprised of a more rich and varied set of user micro-practices operating within an ecology of numerous, partly overlapping, niche-oriented information systems. As Scott (1998, p. 138) points out, "There is a larger argument to be made for cross-use and diversity [i.e., poly-cropping] … more resilient and durable … [and] sustainable" eInfrastructure. A fundamental mistake, Scott (1998, p. 133) goes on to say, is, "to infer functional order … from purely visual [or formal] order. Most complex systems, on the contrary, do not display surface regularity; their order must be sought at a deeper level."

The metaphors of ecology and poly-cropping relate to biology and social order, not to e-Infrastructures per se. Yet the dynamic patterns of evolving, historically stratified e-Infrastructures of the kind we empirically examine display interesting similarities we set out to identity.

Section 2 presents our methodological approach. Section 3 outlines the business environment of NorthOil, which serves as the backdrop for the empirical study, and presents production optimization, the activity we empirically focus on in this paper. Section 4 traces the micro-level practices and technologies involved in production optimization, specifically looking at how well information history is created, maintained and made sense of. Section 5 extends our analysis by discussing implications of the transformative and assimilated work practices based on a selective combination of top-down mono-cropping and bottom-up poly-cropping. This constitutes an important and underexplored middle-ground position between idealised top-down eInfrastructure efforts and romanticized portraits of unchanging local practices.

2. Methodological Approach

We have employed an interpretive approach to understanding the reciprocal influences of information systems and their contexts (Walsham 1993, pp. 4-5). We draw selectively on relevant methodological principles outlined by Klein and Myers (1999) to make our approach explicit and to reflect upon the strengths and weaknesses of our work.

Klein and Myer's first principle deals with the hermeneutic circle, that is, how our understanding of the whole is linked to our understandings of the parts. Their second principle deals with historical background. We have combined these two principles. The work with SharePoint is a continuation of previous work we understood in the late 1990s (Monteiro and Hepsø, 2000; Monteiro and Hepsø, 2002) to study the introduction and proliferation of a Lotus Notes-based infrastructure in the same company. We have created a historical reconstruction of the whole process around the introduction of SharePoint in NorthOil from 2003 onward. This reconstruction is based on some of the same themes that we addressed in our study of NorthOil from 1992 to 1998 (Monteiro and Hepsø, 2002). In addition, we have undertaken several targeted case studies (including Rolland, Hepsø and Monteiro, 2006; Hepsø, 2009) during which we have come across issues of relevance to our interest in the Lotus Notes/SharePoint infrastructure. This has enabled us to move back and forth between the parts and the whole. In our previous work (Hepsø and Monteiro, 2002), we developed a scheme where we added a number of categories with dated episodes and trends during the years 1992 to 1998, and we have tried to follow the same threads from 1998 to 2007. These categories are: external conditions, prevailing management strategies, major IS projects, the rise and fall of key organizational actors, important organizational development projects, and the dates of important events in the technological solution directly connected to the establishment of the Lotus Notes and, later, the SharePoint infrastructure. By using the time dimension as our anchor, we have analysed how the development of both the Lotus Notes and SharePoint infrastructures were connected to a number of company efforts evolving in a larger market setting: for instance, the consequences of the high-profile implementation of an ERP, or how fluctuations in oil prices influenced the level and intention of eInfrastructure investments.

Klein and Myers' third principle addresses interaction between researchers and subjects. Of great importance here is to reflect critically on how the data was socially constructed through interaction between researchers and participants. Our access has been facilitated by our relation to NorthOil over a long period, and we have conducted interviews and observed participants over several years (see Table 1 for details). One of the authors has worked for NorthOil the last 15 years, including three years in production optimization, the major empirical setting of this paper. This has given him detailed information about the issues, people, data sources and the context under investigation. While the fact that he has worked in NorthOil makes him biased, it is also the case that it would be difficult or impossible for an outsider to develop the same depth of understanding. We have dealt with this bias in two ways. First, the relation between the NorthOil internal and the two external authors must be seen as dialogical, in the sense that the external authors played the role of devil's advocate." Second, we tried to address this bias by seeking to validate our findings and discuss our account of the case with involved actors, and partly by relying on varied and independent sources of data that the external authors collected and analyzed. Digital data sources related to the issue under investigation were considerable (see Table 1). All three authors have been, to varying degrees, involved in conducting 38 semi- and unstructured interviews lasting one and a half to two and a half hours (for more details, see Table 1). Klein and Myers' seventh and final principle is that of suspicion. It requires sensitivity to possible biases and systematic distortions in the narrative collected from the participants. The digital material archived in NorthOil's Lotus Notes and SharePoint databases has provided 'raw' material that can be interpreted as texts. Of special importance is the information from digital communication captured in both Lotus Notes and SharePoint, giving the researchers access to substantial archives of communicative interactions (see Table 1).

Table 1. An overview of our empirical sources: digital data sources, interviews and observation

Digital data sources	Lotus Notes/SharePoint databases, shared file drive G-disk)	Well history of NorthOil assets
	Private email	Private e-mail messages sent during projects and handed to us as a consequence of interviews and discussions
	Intranet-based sources	Official project information of the Intranet related to IS/IT-issues Lotus Notes and SharePoint reports-documentation available on search on NorthOil Intranet
	Internet-based sources	Official NorthOil information on the Web
Semi and Unstructured Interviews	38 interviews • 5 taken part in SharePoint implementation • 3 managers and decision makers IS/IT • 12 production engineers • 3 maintainance engineers • 3 asset onshore managers • 6 offshore control room operators • 2 offshore process engineers • 4 offshore managers	Key people in the implementation process of SharePoint both as managers and project personnel Key asset people working within the domain of process and production optimization
Observation	• Participant observation of pilot in production optimization 1-2 days a week over three months 2005 • Direct participation of observation of production optimization in asset, around 14 days over a period of 4 months • Two trips offshore to observe work, total five days • Ongoing observation and participation of production optimization work by NorthOil employee/co-writer 3 years • Participation in 4 asset workshops that dealt with the future of production optimization in the asset	Observation of IT-use, work practices and collaboration with personnel in the assets Observation of internal NorthOil organisation development project within the domain of production optimization and information management. This has given us access to people and the contexts to develop the necessary understanding and challenges related to the domain The authors have been free to wander about and make appointments — symbolically gestured by the existence of a NorthOil based e-mail address — this have greatly facilitated our ability to select and identify interesting sources of data rather than being closely steered.

3. Accountability and Traceability across Time and Space: The Case of Northoil

3.1 Business Context

Global oil and gas companies like NorthOil face steadily fiercer competition for scarce resources. The pace and scope of mergers and acquisitions is intensifying. The move to exploit ever more remote and more difficult to access oil and gas resources throughout the world has driven a notably greater concentration of financial, technological, and skills-based resources than found in many other business and industrial settings. NorthOil is no exception: Its production outside its traditional home ground in Northern Europe nearly doubled in 2006.

Simultaneously, NorthOil is investing heavily in technological and organisational changes, allowing continued, commercially viable production in the increasingly elderly assets on the Norwegian continental shelf. The traditionally huge, monolithic, concrete, and tremendously expensive oil installations have been supplemented and substituted over the last decade or so by networks of interconnected, “light-weight” subsea installations, thus lowering investments barriers. Continuous focus on sustaining or improving production and recovery from existing oil and gas fields is of great importance for the company.

Following NorthOil’s listing on the New York Stock Exchange in 2001, there has also been renewed and vigorous attention placed on systematic documentation. In response to the major financial crises (notably Enron), new legislation both in the US and in Europe has emerged to increase the traceability and accountability of business transactions and critical decision processes. In the US the Sarbanes-Oxley (SOX) Act of 2002 has driven the need for effective internal control systems built on heightened requirements for documentation of key organizational decision points (see paragraph 404). Thus, all companies listed on the NYSE are affected.

This emergent business context has had strong influence on the NorthOil IT department’s policy for implementing a new corporate-wide collaborative platform. After an initial pre-project to survey several alternatives, the IT department in 2002-2003 settled for a SharePoint-based platform. SharePoint complied with SOX requirements by providing functionality for tracing different versions of the same document and for producing an integrated archive of activity across multiple organizational and geographic divisions within the company. The older Lotus Notes-based eInfrastructure introduced in NorthOil during the 1990s, for all its merits, had significant problems facilitating document searches *across* different sites and revision control, a prerequisite for being SOX compliant. SharePoint was also seen by the IT department as a particularly attractive alternative because of its functionality to tag and filter documents according to a pre-defined set of meta-data. This ability was perceived as an important component of a future solution to the current problems of searching across enormous quantities of fragmented information and documents. Thus, SharePoint appeared to be the ideal vehicle to address the new concerns embedded in SOX compliance. Furthermore, SharePoint also fit well with an overall IT strategy favouring Microsoft applications and technologies.

Implementation of SharePoint, under the banner of “Collaboration at NorthOil” (C@N), picked up in 2005. This process, however, was not without incident. The overall strategy was to use the templates provided by SharePoint (i.e., an “out-of-the-box” strategy) and customize as little as possible. This was an immediate reaction to the mixed experiences the company had with the opposite strategy when implementing the estimated $300 million ERP. That project was delayed due to greatly underestimating the effort of developing various customized components needed for integrating other systems (archiving systems, Microsoft Office, and Outlook, etc.).

The “out-of-the-box” strategy has proven immediately problematic. First, the meta-data taxonomy is often used in unintended ways. For example, users select keywords so that it is possible to structure and filter information in a document workspace as if it were sorted in folders. Second, as with most taxonomies (Bowker and Star, 1999), it is not always evident what kind of category is best suited for a specific document. As a result, as noted in an internal evaluation, documents across different document workspaces are as hard to locate as ever. Moreover, as noted by a production engineer, instead of searching SharePoint, users tend to go back to the old Lotus Notes databases, since this is still a place with a large amount of historical information.

3.2 Three Disciplines: Reservoir, Production and Process Engineers

The aspect of NorthOil's vast activities we focus on, production optimization, deals with short- and long-term control and optimization of oil and gas flows. With a network of subsea wells, this entails control of non-linear interaction across and among coupled wells and local optimization (Perrow, 1984).

Production optimization can be defined as the process for short- and long-term control and optimization of oil and gas flow in a value chain from reservoir, via offshore facilities to export from installations. Such optimization entails new demands of legitimising decisions by tying these to interdisciplinary and historical accounts of the wells. The key issue is who produces these accounts and for what purpose.. In Figure 1 we present the overall ecology of an oil and gas asset as it moves from the reservoir to the market. This ecology consists of several sub-ecologies or key niches with strong dependencies; reservoir management, well optimization, process optimization, production optimization and logistics related to bringing hydro-carbons to a market. In this ecology we focus on the relationship among three niches, each with their own communities, work practices, and existing infrastructure. These three niches correspond roughly to the technical disciplines involved in production optimization: *reservoir engineers*, *production engineers,* and *process engineers*. They inhabit different parts of the oil the and gas value chain and are located onshore. The reservoir engineers are responsible for updates of the subsurface model when production changes the properties of the reservoir. Production engineers are responsible for maximising production from existing wells up to the so-called "separators" (separating oil and gas from water) on the platform. The process engineers are responsible for modeling and ironing out bottle-necks in the flow from the separation facilities and onward. Daily process-control and optimization is handled by offshore control room operators supported by process engineers. These offshore operators monitor technical systems and equipment, critical issues related to safety like emergency and process shut-down alarms, and minute-to-minute production.

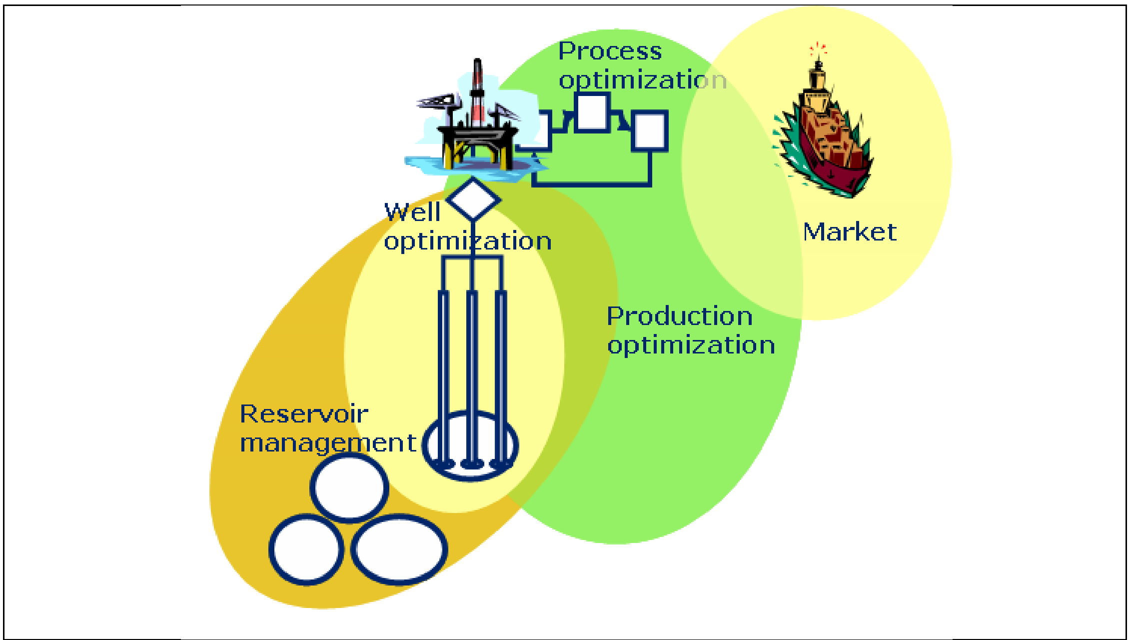

Figure 1. An abstracted account of the the value-chain of oil production, emphasising the roles of reservoir engineers, production engineers, and process engineers

The three niches operate in different temporal structures (Orlikowski and Yates 2002), employing dissimilar timing norms. While the reservoir models have a long time constant (usually changes in drainage strategy take months/years to show effect), changes in process and production are almost instantaneous. Reservoir management aims to optimize reservoir performance over the life of the field, while production management optimizes the well production and injection, production network, and process facilities on a day-to-day basis.

The subsurface communities of production and reservoir engineers are never able to directly access the reservoir they assess. Only mediated by numbers, plots, and models can they gain an understanding of the reservoir and production performance. Their reservoir and production knowledge is shared via objects that are denoted with attributes mostly based on sensors or modelled data. A fit for purpose and pragmatic thinking guides what type of objects will suffice to discuss the reservoir in this particular situation. To illustrate, production and reservoir engineers collaborating in a discussion about the production challenges from wells in a particular reservoir drew a simplified map of a particular part of the reservoir (a segment) on the Smartboard (see Figure 2). To enable discussion between production and reservoir engineers, the reservoir was simplified into a few but important parameters, of which the most important were pressure, zones, and faults. The circle tagged "Pr." in Figure 2 is the pressure in the bottom of the well, "Qo" is the oil production rate and "WC" is water-cut in the well. Oil production (Qo) in the three wells ranges from 450 to 900 Sm3/d. Measurement equipment put into the well after production indicated there was a dramatic increase in the water level, so they agreed to reduce the reservoir pressure in A-56 by reducing water injection into this well.

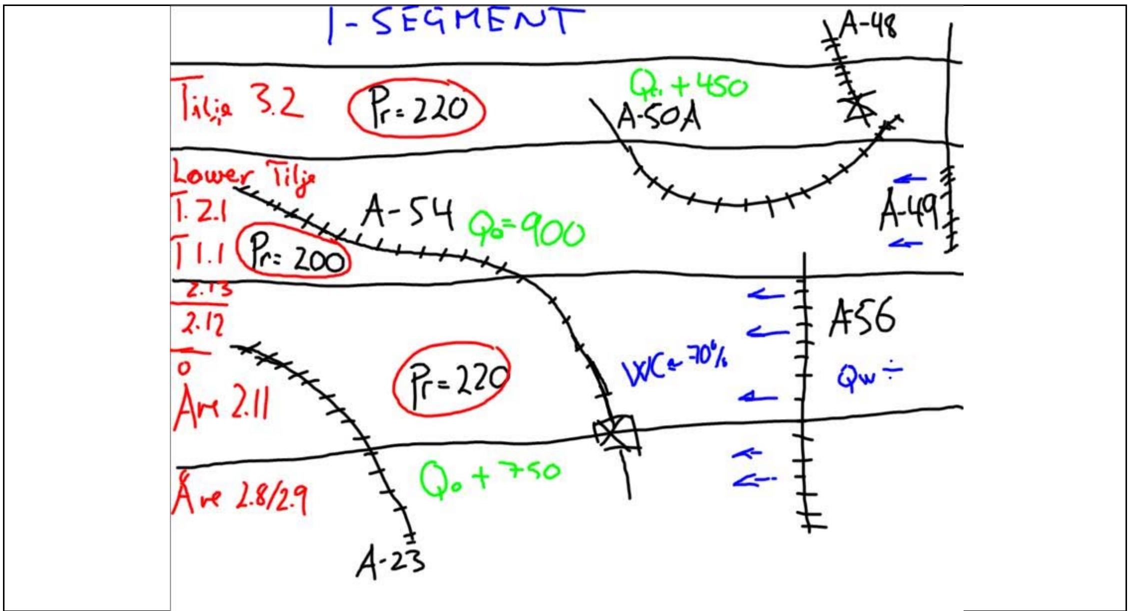

Figure 2. A boundary object that enabled perspective taking between the production engineers and reservoir engineers

The subsurface details are not important for our purpose, but production engineers with the help of a reservoir engineer who had the necessary reservoir knowledge analysed the connections among the wells A50a, A49, A56, A23 in the "I-segment." The communities of knowing shared vital parameters; naming conventions like "Åre-Tilje," position of the wells in the segment, flowing connections, pressure, water-cut, and others. The total relationships among producers and injectors in the segment were addressed and simplified, and through perspective taking (Boland and Tenkasi, 1995), they were able to return the well to its previous production level.

3.3 The Niche Systems: From Structured to Unstructured Data

The e-Infrastructures that support communication between and inside these niches can be divided into two major clusters (see Table 2 for the collection of both). The first part is the installed base of sensors that deliver structured, real-time data from wells and production facilities such as time-stamped pressure, temperature, and flow-rate data from tags in wells and production lines. This tag information is read once a second by the safety and automation system (SAS) that controls critical functions of the oil installation's wells and process systems. The SAS then records the data in a data historian database (IMS), where the real-time tag values are stored in a predefined tag-structure.

Table 2: Key eInfrastructure Systems

Name of system	Definition of system
High-frequency structured information domain	
SAS	Safety and automation system. System that controls the major safety and shut-down functions of a facility. It is also connected to sensors that deliver real-time stamped data of pressure, temperature or flow from tags in the same wells and production lines
IMS/Historian	Database that stores time-stamped data from SAS in a predefined well and facility tag structure
Prod	Is the corporate system/database for production reporting (production, injection and export). It documents the production of an asset throughout its lifecycle. All official production statistics and well history/chronology should be placed in Prod
Non-structured information domain	
Shared G-drive	A Microsoft Windows-based collapsible folder structure (Windows Explorer) where heterogeneous information files can be stored in a predefined and adjustable structure, see Figure 4
Lotus Notes	Is a groupware system developed by the Lotus Corporation (now IBM). It is an asynchronous tool that can be used by individuals and work groups accessing shared databases in local or distributed computer networks. Implemented and used in NorthOil from 1994 onward, see example in Figure 5.
Arena	Asynchronous collaboration tool developed in Lotus Notes to structure various kinds of unstructured information associated with ongoing tasks. It offers a structure to this information using case folders. Tasks and folders that are completed can be exported to an electronic archive, see example in Figure 5
SharePoint	Is a browser-based collaboration and document-management platform from Microsoft. It can be used to host websites that access shared workspaces and documents. Implemented and used in NorthOil from 2003 onward.

Prod is a corporate-wide IS containing production information and comes with a wide range of different tools for collecting, analysing, viewing, and running different calculations; in this regard, it functions as a hub that takes and processes data from the historian (IMS) and other sources. In addition, numerous other systems rely upon Prod for data retrieval, including for input to key performance indicators and portals. Several specialist systems for analysis of well performance and optimisations are in place. Specialised spreadsheets can integrate data from Prod and these production specialist systems. Prod data can also be taken into earth science and reservoir modelling applications.

Prod samples regularly tag values from the historian/IMS, as do several of the systems that aggregate real-time data to support production optimization work. For practical purposes, we call this the *high-frequency structured infrastructure domain*, because it delivers real-time data in a pre-defined tag structure. Most of the valid input data that production and process engineers use in their daily work for diagnosis and analysis stem from these high-frequency structured data-sets. However, in order to use these data-sets in practical work for collaboration both within and across the niches, the data has to be taken out of their high-frequency and structured settings and applied in more local situations. Prod is one such application used for production reporting.

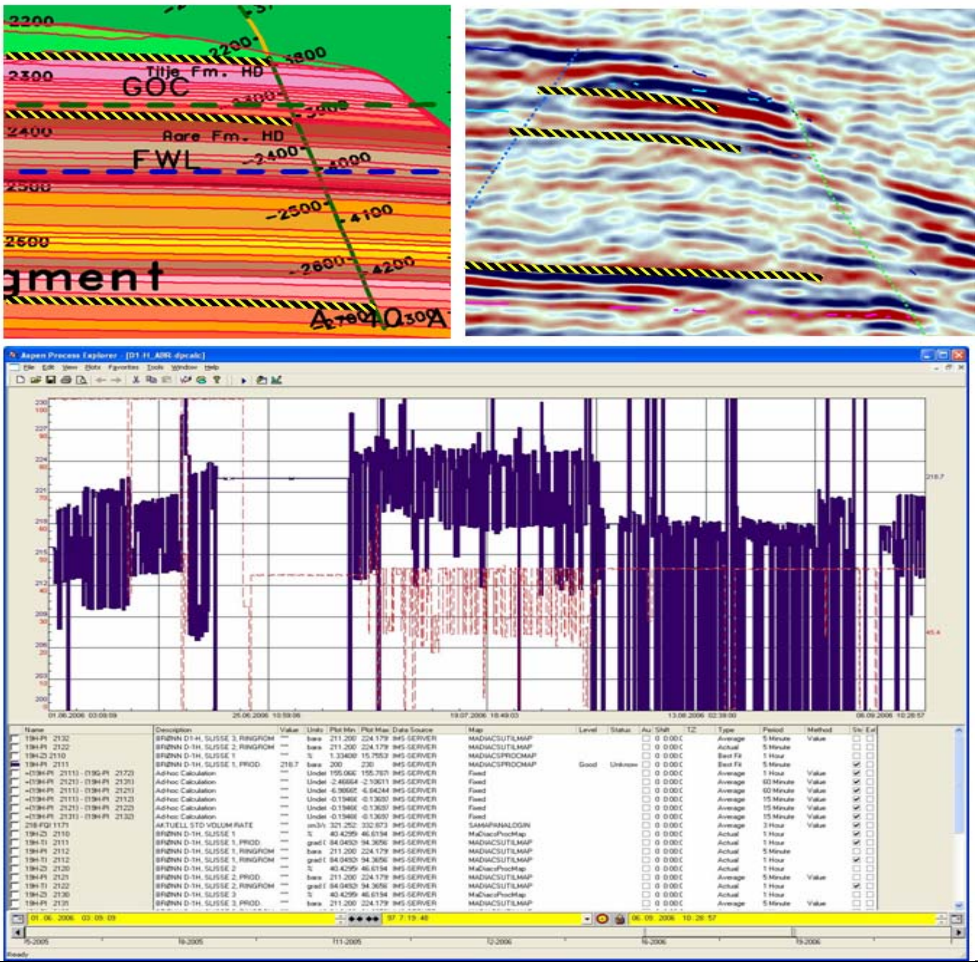

Figure 3: Above-left: a drawing of a strategraphic map of layers and a position of a well comparable to the object in Figure 2. Above-right: a seismic or geo-physical map of the same structure with graphical annotations. Below: a production engineer plot used to analyse the performance of a well.

In addition several historians come with a front-end that makes it possible to visualise real-time data in plots and tables (see Figure 3). Several portal solutions exist for the same purpose. They aggregate and publish real-time data in a structured way tailored to the needs of the niches involved. For instance, the process engineer applications typically process selective facility tag data when conducting a simulation of bottle-necks, while the production engineer applications are more concerned with tags that show production from the wells like Prod. There is considerable overlap of tag data use across niches, which means that pressure and temperature data from one tag can be used for different purposes by different niches in their particular tools. The tools are, therefore, domain-specific and specialised to deal with specific work tasks and practical problems within the niche. In many cases these specialist systems are only used by people in the same niche. The high-frequency structured data infrastructure is constitutive for the work of the niches involved in production optimization. The high-frequency structured information domain in the upper half of Table 2 is not directly part of the SharePoint infrastructure at NorthOil, but it is presented in some detail, as this installed base of specialist systems influences the actual usage of SharePoint and practices of information management.

4. Discussion

4.1 Archaeology of Systems: Historical Stratification

The domain associated with SharePoint is what NorthOil calls the infrastructure domain of *non-structured data (bottom half of Table 2)*. Before moving to SharePoint, it is worth exploring this domain in more detail. For people in these niches, non-structured data are contained within systems that add value to structured real-time data. For instance, real-time data are imported into a spreadsheet to provide a new method or equation to calculate pressure build-up in the wells. A document report concerning the last production log in a particular well can give important information concerning the well. Quite similar to a medical patient journal, the production 109 stores information concerning the production history of the well: drilling/completion records, measures taken during the history of the well, diagnoses, etc. NorthOil policy requires that the official well history or chronology should be maintained and updated in Prod, where each well is given a timeline based on periodic reports using a predefined set of keywords. However, practices associated with *use* of the well chronology show considerable variation, because Prod does not contain all of the details required by production engineers in future work with the well. A production engineer is not able to link up and assess the many email communications, reports, logs, and analysis results that accumulate through the production history of the well via the well chronology in Prod. The people working within and across the niches of production optimization need to share and collaborate using these non-structured data-sets. Therefore, most niches have adopted the strategy of setting up niche-specific information spaces with their own internal structures. To understand and access the information space of the production engineer, one must know how activities and the knowledge domain are organised. Since the non-structured information space evolves over time, engineers are also dependent upon knowing the practices associated with the use of the information space. This constitutes a significant barrier for rookie production engineers, who find themselves entering a familiar domain but with unknown local practices.

Historically there have been at least three ways of addressing the well history challenge in NorthOil: a shared disk drive, Lotus Notes/Arena, and SharePoint. The first solution to the well history challenge was to store it on a shared file drive (G-drive) using Windows Explorer, with separate user communities developing domain-specific folders in the shared G-drive. Under this solution, the history of each well was confined within single Word documents (see Figure 4 below). Some assets within NorthOil continue to be represented and managed following this pattern.

In the mid 1990s NorthOil implemented Lotus Notes on a broad scale (Monteiro & Hepsø, 2000) for document management, email, archiving, and collaboration purposes. The shared workspace collaboration system Arena in Lotus Notes became widely used throughout the company, in particular for collaboration support around unstructured tasks. Using Arena, such tasks were captured using a pre-defined structure of folders containing all information (administrative, documentary, task-related, etc.) related to one case. Case covers, managed by case managers, collected tasks and documents of multiple formats (text, spreadsheets, slide presentations, etc.) produced in connection with specific projects. Completed tasks and folders could be subsequently exported to an electronic archive. While everybody in NorthOil had access to Arena databases, in practice, departments and projects quickly developed separate Arena databases partly attuned to local needs and concerns. For every asset, production engineers set up a structure of folders/cases containing well history, supplanting in many (but not all) cases the older G-drive strategy of information management and coordination.

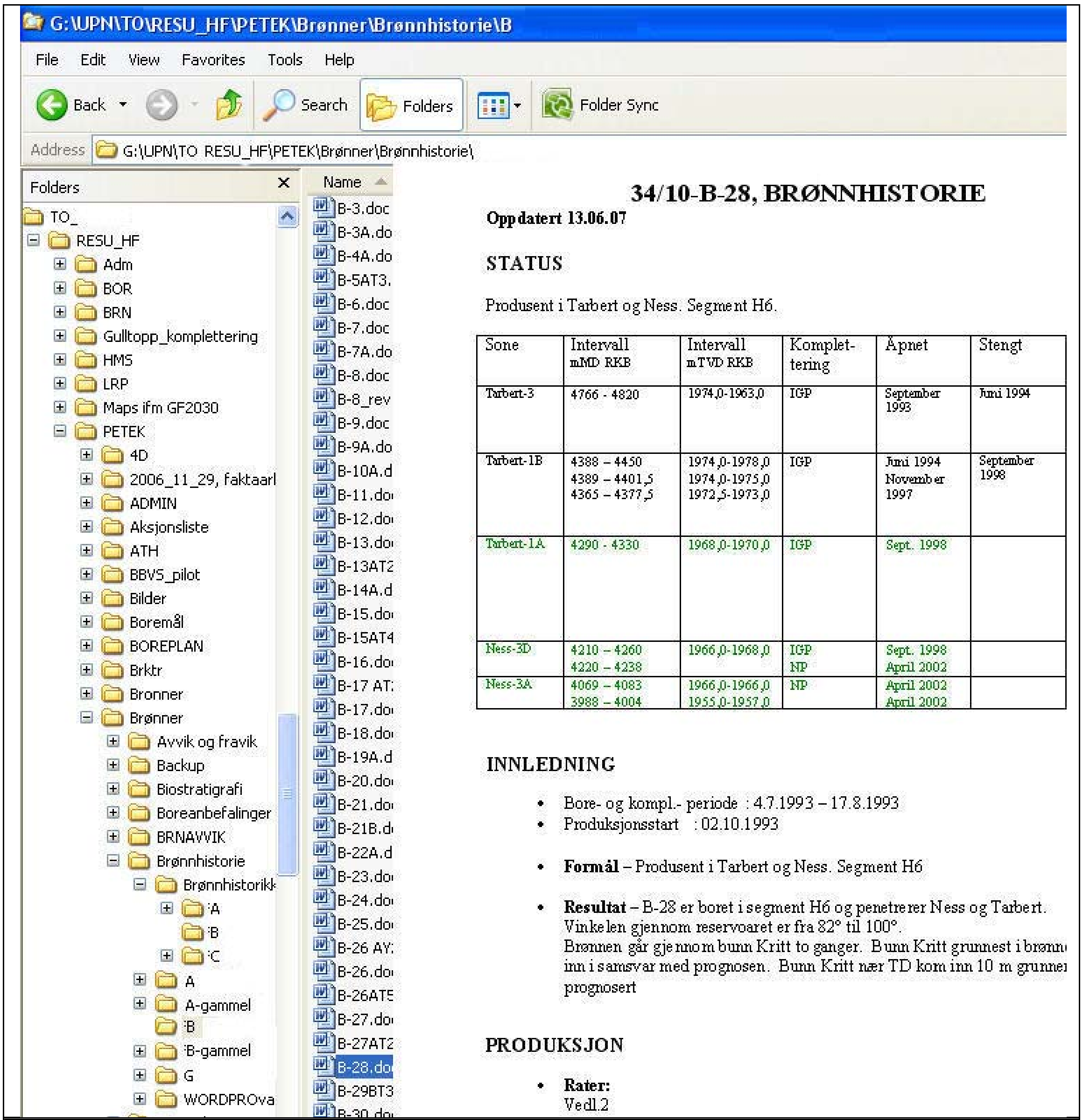

Figure 4: Well history in a shared file drive

This solution made several work practices related to well history easier. Arena came with a collaboration tool so it was faster to move documents and e-mail associated with the well into the folder. The functionality of hyper-linking made it possible to connect information available in other Lotus Notes databases, developing a simple portal functionality, as represented in Figure 5:

In the well history of D4 are embedded links to other Lotus Notes documents giving supplementary information on this particular well. Such supplemental materials could include e-mail, additional logs, documents, outstanding tasks, lists of telephone numbers, or slide presentations.

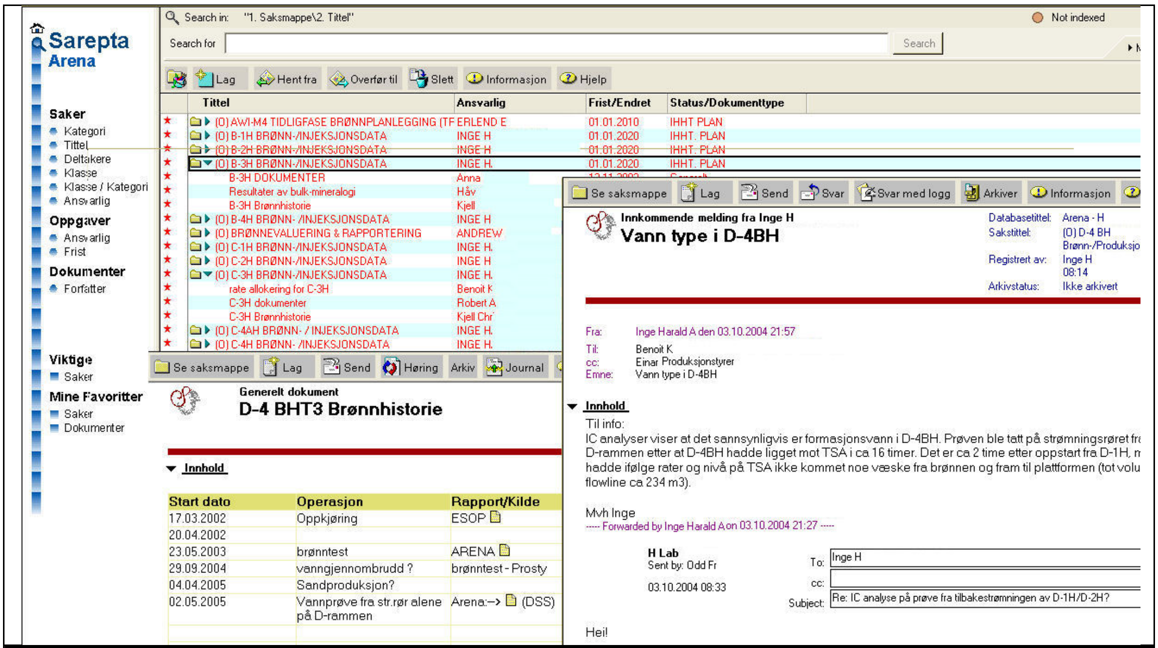

Figure 5: Well history D-4 in a shared Lotus Notes workspace with linked information resources

To summarize, prior to the SharePoint implementation at least two established work practices (with varieties) related to production history existed in the company. Some assets never took the step to the Lotus Notes/Arena solution because too much of their practices and data was associated with sharing information on the shared G-drive. Other assets continued to have old well information in the G-drive and new well information in Notes. For those who continued to use the G-drive, this became increasingly difficult since many whom they had to collaborate with used Lotus Notes for similar purposes. Such challenges became apparent, for example, when production engineers had to send unstructured data to other departments and groups with which they collaborated. As one production engineer reported:

> *When we request some work to be done with an existing well, we have to use the Arena of the drilling people and manually enter the well history from the G-drive into the Notes document. The department responsible for well work-overs have made a Notes database where all requests are stored and processed. They cannot find our well history and want us to use their system for this. If we don't there will be no well work-over…*

By contrast, new assets that started using the Lotus Notes/Arena solution were more easily accommodated within collaborative efforts.

4.2 Re-Construction of Production History

The number of wells production engineers supervise varies as does their type. Most are so-called "producers" while others are "injectors." The injectors are used to inject water back into the reservoir to maintain reservoir pressure. Each well in the dispersed network is located at a strategic point in the reservoir. Contrary to the belief that an oil reservoir is a homogenous "tank of oil" the reservoir is complex, with faults splitting it up into segments with diverging vertical and horizontal flow conditions. The key to production optimization is to analyse different measured parameters available through Prod and other partly compatible systems in order to estimate production, and take action if needed for optimizing. A production engineer explained:

> *We develop an increased understanding of how wells interact through the production history. The key is to see the wells together since the optimization of one well might*

lead to loss of overall production given the right circumstances. When doing this evaluation and analysis work we juggle between parameters; temperature, pressure, water production, production rates, gas and availability of equipment in the offshore process plant.

In order to reconstruct this production history and to make sense of it in a given situation, production engineers use real-time data, analysed and aggregated via a wide range of different information systems. As a consequence of historically entrenched practices, different local adoptions, and NorthOil's many attempts at introducing new e-Infrastructures, this history has to be somewhat painfully reconstructed by tracing information through many systems: Prod, the system that publishes the daily drilling reports from each asset, the database that describes the technical completion design of the well, the old Lotus Notes environment, the newly implemented SharePoint, and a variety of other spreadsheets stored at fileservers. As noted by an experienced production engineer, this is not a straightforward task for rookies:

If you didn't follow the well from its inception, there is no way you can know where to find the information or what kind of information that is available. Thus, it is also impossible to just use the search engine

Historically there have been attempts at collecting all well information in Lotus Notes databases. Thus, a large chunk of historical well information is found here. However, after the recent introduction of SharePoint, these databases are no longer updated. In addition, since it is not possible to create hierarchies of document folders in the current configuration of SharePoint in NorthOil, production engineers store only bits and pieces (typically collections of links) of well information in SharePoint and the rest on a fileserver. The current SharePoint version also has a weakness with macros. Most spreadsheets use macros that will not work when posted on a SharePoint server. As expressed by a production engineer:

The G-drive is a good alternative. You can always expect it to exist. But, again, the problem is that we have a complex tree-structure [of folders] and you need to have been working here for some years in order to find something.

Contrary to intentions, then, the SharePoint solution has re-introduced fragmentation of well information and added additional layers of complexity to efforts to work across assets and project teams. In partial response, production engineers have developed a cascade of different articulation activities, ranging from validation of information and data, comparing-contrasting, and other strategies for double checking available information. Different representations are used to develop useful understandings of data and information before they are applied in specific well settings, in particular in support of the group's efforts to track well and flow-line performance, diagnose wells with deviating behaviour, and monitor water breakthrough in the wells. As one production engineer puts it:

When we do this work we are also identifying constraining elements and the effect these elements can have on production vis-à-vis increased well potential, flow restrictions, reservoir drainage strategy and process limitations. We give various types of input to both reservoir engineers and people responsible for running the oil installations operations onshore and offshore.

Several morning and ad-hoc coordination meetings are held with involved groups offshore and onshore that execute changes in the process facilities and choke valves in the wells (e.g., control room operators). During these meetings, wells figure centrally in the agenda, and short'- and long-term action points are taken back to the community for more detailed analysis or immediate trouble-shooting.

Production optimization in practice typically involves using a number of different IT-systems, including a variety of crucial spreadsheets and templates. Here, fragmentation in eInfrastructure emerges as a central problem. As stated by an experienced production engineer responsible for a number of sub-sea wells, the problem is "that you don't get all the data needed in one single system." For example, when conducting "well testing", the production engineers in one asset use a front end to the historian/IMS in order to survey the wells' temperatures, pressures, and rates. If a test is successful, information about a certain well is transferred to Prod. However, the information in Prod is neither sufficient nor specific enough to calculate production rates. To work around this problem, engineers will typically select a data-set representing a certain period of time (for example a month), and then import this into a spreadsheet using a pre-programmed macro function. However, since each subsea installation consists of a template with four to six wells, and rates need to be estimated for each well, this is done more or less “by hand” in the spreadsheet. As one production engineer reports, *“We have to manually assign production to the different wells.”*

Interestingly, “manually” here implies using all information available (from the well chronology) in order to assign the most likely rates on each well. Before the actual calculation, the data goes through a discretionary process of screening out what is perceived to be “unlikely data” (e.g., too high or low values). In this sense, the spreadsheet becomes a vital part of the well history, because it provides additional information about this process and incorporates important elements of expert judgement. But since these sheets have macros, they cannot be stored in the current version of SharePoint used by NorthOil.

5. Conclusions

Post-Enron legislation has underscored and boosted concern for increased accountability and traceability through more systematic and comprehensive documentation of relevant business processes. This applies also to the commercially vital work processes around production optimization in NorthOil. The recent introduction of a SharePoint-based eInfrastructure — subsuming the many fragmented, niche-based and specialised information systems — seems, on the face of it, an adequate response to these concerns.

Our story calls this conclusion into question. Through a historical reconstruction of the development of a SharePoint eInfrastructure in NorthOil, we critically examine the aspirations *and* practices of complete and comprehensive seamless integration of distinct functional, geographical, and technical components. We discuss the development of NorthOil’s working eInfrastructure as an ongoing effort that must be understood in both a global and a local setting because decisions need to be traced historically in time. The production trajectories of oil and gas wells are maintained and constructed historically across technological platforms, disciplinary and geographically boundaries.

In our analysis, we have highlighted the persistent importance of the patchwork of the installed base of local, niche-oriented applications around production optimization. But this should not be misconstrued as suggesting that existing practices are somehow immune to the change efforts embedded in the SharePoint eInfrastructure. The NorthOil SharePoint story represents, rather, something of a middle position between overly ambitious agendas and accounts of transformational change (including the one motivating the introduction of SharePoint into NorthOil in the first place) and, on the other hand, overly conservative accounts of the durability and resilience of local practice. Rather than simply observing stubbornly prevailing local practices, what is emerging in NorthOil is closer to an *amalgam* of existing practices moulded with selective elements of the new eInfrastructure — a finding with important practical, managerial, and analytic implications.

One practically relevant implication concerns the discussion on taxonomies and meta-data, which is at the core of information management in NorthOil. The top-down generated classification schemes provided by SharePoint have in some networks been worked around. Over-writing the default values specified, some communities are modifying — but not rejecting — the SharePoint search eInfrastructure. In a recent response to mounting dissatisfaction with the rigidity of SharePoint, NorthOil opened up free-text fields in the classification scheme of SharePoint. Similarly, the latest version of SharePoint includes Web 2.0 functionality. The coming of open architectures and Web 2.0 herald the availability and access to data whether stored on a shared drive, Lotus Notes, SharePoint, or any other system open to access given the necessary rights. Even though data access concerns may be partly resolved in this way, major issues around data management, quality, and information seeking/retrieval will remain. We have shown that the reliance on top-down, planned meta-data structures is too optimistic. However, we are not advocating fragmentation or that doing nothing is an option. Bottom-up folksonomies emerging from new Web 2.0 social software are emerging in pockets within NorthOil. Folksonomies are user-generated, therefore inexpensive to implement and can potentially develop into an emergent business taxonomy in areas like production optimization. As we see it, they can be an add-on to institutionally supported taxonomies, controlled vocabularies, and meta-data strategies in SharePoint, since such classification practices advocate and nurture local practices. Such bottom-up strategies also support the distribution of information classification to those professionals who are actually doing the work. We imply from our work that the development of a *collabulary* (blend of collaborative and vocabulary) is an option. This middle position is the compromise between the hierarchical meta-model and the folksonomy. Here, a team of classification experts collaborates with domain professionals in various parts of the business to create rich but more systematic content tagging systems. A collabulary of an information infrastructure would arise much the way a folksonomy does. It would be constructed primarily by domain experts close to practice, thereby capturing the benefits of folksonomies: low investment costs and a rich and practically-grounded vocabulary that is understood and makes sense in the contextual domains of the users. Having the necessary link to practice would also ease the capability to respond quickly to changes in classification practices — without the shortages of too simplified folksonomies.

An implication related to managing eInfrastructure development is that the introduction of systems like SharePoint at NorthOil seems to follow two integrated and repeated cycles. The first cycle involves an attempt to *control* and get a grip on the heterogeneous information resources enmeshed in practice by imposing a structure in the form of shared drives, Lotus Notes, or SharePoint. These new structures create a new amalgamated order based on the new, attempted order and existing practice. However, since there will never be a perfect fit between these two, *fragmentation* tends to be the consequence over time. This is the second cycle. The implications for practice are that the existence of such cycles must be acknowledged in infrastructure development projects. As a management challenge, in general, this is about living with the paradoxes of taking control vs. cultivating the practices of the organization. However, the paradoxes here have gestalt features that force the execution into either the control or cultivation trajectory. Once the control trajectory is taken, the cultivation trajectory becomes hidden and vice-versa. If the trajectory of control is prevailing, the solutions tend to come up with more control, typically manifest as top-down initiatives. There is a deep seated formative context (Ciborra 2000) and strong connotations of order and mess (Monteiro and Hepsø, 2002) that structure these trajectories.

Accordingly, there needs to be some space for evaluation of existing practice in heterogeneous domains like the production domain in our case. This can be regarded as a simple comment, but still seems to be disregarded in many of these projects. As the aim of an infrastructure is necessarily often unclear and is an ongoing and changing target, measures have to be taken to involve a variety of actors, perspectives, and interests when situated opportunities emerge. The importance of seizing the opportunities that drift along clearly suggests the need for some slack. Being alert and seizing these opportunities require work and resources and points to the need to be open to compromises and not worry too much about creating a mess (Monteiro and Hepsø, 2002).

Analytically, our study implies promoting a view of working e-Infrastructures much along the lines of what Timmermans and Berg (1997) call “local universalities.” Through their work on clinical protocols, they point out that minor and not so minor deviations are practiced routinely. At times the users go beyond the boundaries of the protocols, making ad hoc decisions and even repairing the deviations of others. An important point, however, is that such tinkering is not a failing, but a prerequisite for the protocol to function (ibid., p. 293). Working e-Infrastructures, then, transform both the new eInfrastructure *and* local practices.

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