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# Characterising Integration in Practice: A Case Study of Collaborative Infrastructure Change in a Large Oil and Gas Company

Thesis for the degree of Philosophiae Doctor

Trondheim, February 2011

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**NTNU**
Norwegian University of Science and Technology

Thesis for the degree of Philosophiae Doctor

Faculty of Engineering Science and Technology
Department of Engineering Design and Materials



ISBN 978-82-471-2610-3 (printed ver.)
ISBN 978-82-471-2611-0 (electronic ver.)
ISSN 1503-8181

Doctoral thesis at NTNU, 2011:44

Printed by NTNU-trykk

# Abstract

This thesis investigates collaborative work practices in a large oil and gas company (OGC), with special attention being given to recent integration and standardisation efforts to the collaborative infrastructure for improving knowledge sharing practices across disciplinary and geographical boundaries. Through a longitudinal case study, the thesis investigates how these efforts unfold in different organisational contexts.

This dissertation is inspired by social studies of Information Systems (IS) and more recent debates on the mediating role of integrated systems. Drawing on the interdisciplinary field of science studies, the thesis investigates how working integrated systems are established in practice.

Through the use of vivid empirical examples, previous research has illustrated how various systems do not account for locally unique practices, resulting in them having to be worked-around. In this research, we make a distinction between stand-alone and integrated information systems since local enactments have different dynamics. In particular, we argue that as opposed to largely local, independent contexts of enacted technology, the use of integrated systems implies the interdependent enactment across contexts now linked as a result of the integration. For that reason, we aim to contribute to a higher visibility of cross-contextual effects regarding the use of integrated information systems.

The thesis is not restricted to investigations of a single integrated system, but instead aims to understand work practices which span multiple contexts and are supported by multiple enterprise systems. The primary aim is to investigate the core work practices related to oil and gas production. In contrast to social studies of IS which tend to emphasise that work is a predominantly local affair, our aim is to empirically illustrate and analytically discuss cross-contextual (i.e. non-local) aspects of work. We exemplify the array of strategies needed to sort out local differences and establish cross-contextual work practices, thereby leading us to emphasise the temporal and performative aspects of integration.

As a whole, this thesis investigates socio-technical work practices within a large-scale heterogeneous organisation and aims to contribute to the literature on the social construction of information systems and provide practical implications for managing integrated information systems.

## Preface

This thesis is submitted to the Norwegian University of Science and Technology (NTNU) for partial fulfilment of the requirements for the degree of Philosophiae Doctor. This doctoral work has been performed at the Department of Computer and Information Science, NTNU, Trondheim.

The thesis consists of five papers and additional introductory paper. The introductory paper presents the research motivation and outlines a theoretical framework. Then, the case study is presented along with the methodological approach. Subsequently, the findings of the research are presented followed by discussion and conclusion. The following five published/submitted papers are included as appendixes:

1. Hjelle, T., & Jarulaitis, G. (2008). *Changing Large-Scale Collaborative Spaces: Strategies and Challenges*. Paper presented at the 41st Hawaii International Conference on System Sciences, Hawaii.
2. Jarulaitis, G., & Monteiro, E. (2009). *Cross-contextual use of integrated information systems*. Paper presented at the 17th European Conference on Information Systems, Verona, Italy.
3. Jarulaitis, G. (2010). *The Uneven Diffusion of Collaborative Technology in a Large Organisation*. Paper presented at the IFIP WG 8.2 + 8.6 Joint International Working Conference, Perth, Australia.
4. Jarulaitis, G., & Monteiro, E. (2010). *Unity in Multiplicity: Towards Working Enterprise Systems*. Paper presented at the 18th European Conference on Information Systems Pretoria, South Africa.
5. Jarulaitis, G., & Hepsø, V. (2010). Cross-contextual work practice: Investigating strategies for navigating across islands of knowledge. Submitted to the *Information and Organization* journal.

## Acknowledgments

First of all, I would like to thank my supervisor, Eric Monteiro, who guided me through the maze of theories, asked challenging questions and stimulated analytical thinking. Your supervision and encouragement was invaluable during this research project. I would also like to thank Knut H. Rolland for being my supervisor in the initial phase of this work, and particularly for introducing me to a larger IS research network. I also thank my supervisor Maria Letizia Jaccheri for her support during this project.

I greatly benefited from the Scandinavian IS community. Many thanks to Ole Hanseth, Margunn Aanestad, Ola Henfrisdsson, Gunnar Ellingsen and other fellow researchers who provided valuable comments in PhD Days workshops and the IRIS Conferences.

To my great fellow colleagues and friends: Torstein Elias Hjelle, Thomas Østerlie, Glenn Munkvold, Kirsti Elisabeth Berntsen, Birgit R. Krogstie, Salah Uddin Ahmed, Gro Alice Hamre, Geir Kjetil Hanssen, Ole Andreas Alsos, Tor Erlend Fægri, Vigdis Heimly, Øyvind Hauge, Torgeir Dingsøyr, Sundar Gopalakrishnan, Sven Ziemer and Alfredo Perez Fernandez. Thanks for your friendship, for sharing your experiences, and for your support in difficult moments.

I extend my gratitude to Vidar Hepsø for facilitating access to the OGC, guiding me through a truly complex organisation and providing extensive feedback on my work. I would also like to thank Hans Hysing Olsen for helping me in finding key informants and for providing constructive feedback on my work. A special thanks goes to the many anonymous individuals who willingly participated in interviews and helped me to navigate in the OGC.

This thesis has also greatly benefited from anonymous reviews and fellow researchers in the global IS community who provided valuable comments on my work.

This research was supported by the AKSIO project, which is funded by the Research Council of Norway (PETROMAKS, pr.nr. 163365/S30). This support is gratefully acknowledged.

Finally, I thank my family, and in particular my wife Giedrė, for your support.

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# 1 Introduction

## 1.1 Motivation and research theme

Large-scale public and private organisations are increasingly exploring the various ways in which to improve collaboration and coordination across disciplinary, geographical and organisational boundaries. For instance, in response to diminishing oil reserves, the oil and gas industry developed the concept of Integrated Operations, which refers to more collaborative work practices between offshore and onshore personnel in particular and across the oil and gas value chain in general. In 2006, The Norwegian Oil Industry Association published a report entitled, "Potential Value of Integrated Operations on the Norwegian Shelf" (OLF, 2006), which identified that the realisation of Integrated Operations has a potential value of NOK 250 billion (NPV) over a 10-year period (from 2005 to 2015). The main contributors to this increased value are accelerated production and cost reductions, though these integrating visions are not specific to the oil and gas industry. The health sector, for example, is facing pressure for better and broader healthcare services yet has a need to reduce growing expenditures. The commitment for "shared care" or "integrated care" reflects the ambition to establish effective healthcare services within and across disciplinary and institutional boundaries. The manufacturing industry also heavily relies on supply chain management approaches that aim to integrate the multiple actors involved in the procurement, development and delivery of a product to a customer.

The primary means to achieve the above outlined visions of better integration heavily rely on the establishment of integrated systems. Such systems are particularly attractive, as they promise to eliminate the fragmentation of information by establishing a single data repository (Davenport, 1998). As indicated by Pollock and Williams (2009), an integrated system is not a recent phenomenon, but emerged in the manufacturing industry back in the 1960s. Such systems were developed for inventory control and management of complex logistics when building large assemblages. Since then, the breadth and depth of integrated systems has been continuously increasing and current large-scale organisations heavily rely on a repertoire of integrated enterprise-wide systems such as Enterprise Resource Planning (ERP) for accounting, human-resource management, inventory control, order management, Customer Relationship Management (CRM) for organising and automating interactions with customers, collaborative systems (e.g. Lotus Notes or MS SharePoint) for internal and external collaboration, records management (e.g. MS

Meridio) for centralised record management, and other custom solutions to support specific functions.

Additional pressure and a commitment to exploit integrated systems emerged after a number of major corporate and accounting scandals and the subsequent release of The Sarbanes–Oxley Act of 2002 (SOX), which requires a more systematic control of information, openness and accountability. All companies publicly traded on US stock exchanges have to comply with SOX, and in this context, integrated systems are considered as enablers to achieve the required compliancy. In turn, technology vendors quickly started to promote enterprise systems as a means for achieving SOX compliancy:

> *Companies must implement a means for all departments to contribute effectively, yet have a single system of record. (Industry Directions Inc., 2004)*

In line with major technology vendors, SOX requirements and the above outlined strategic visions across industries, information technology research and advisory company Gartner, Inc. similarly indicates the need for better information integration:

> *To maximize the value of information, enterprises need to integrate the various types and stores of content, integrate content with structured data, and integrate internal content with content and structured data outside the enterprise. (Gartner, 2008, p.6)*

Overall, integrated systems have became the de facto standard for medium- and large-sized organisations (Pollock, Williams, & Procter, 2003). The benefits promised by integrated systems are, however, not easy to realise. Gartner, Inc. estimates that it takes at least six to 18 months to deploy an integrated enterprise content management system. Given the variety of enterprise systems, their modular composition and additional configurational possibilities, organisations invest a considerable amount of time searching for a "good fit" that takes into account both users and managers needs and external requirements. When balancing these various needs, organisations aim to sustain a generic enough package to allow easy updates in the future, yet customise it to establish a better fit with existing practices. This process of finding a good balance translates into significant costs. As Gartner, Inc. suggests, "it is not unusual for an organisation to spend $1 million or more on software and services for a large deal" (Gartner, 2008, p. 7).

The literature, which aims to understand the socio-technical dynamics of design, implementation and use of integrated systems, presents empirical evidence that indicates challenges and problems rather than quickly obtainable benefits. Research on enterprise systems is highly influenced by science studies[1] which have devoted the past two decades to empirically illustrate and analytically argue that technologies do not have deterministic powers, but rather are socially constructed (MacKenzie & Wajcman, 1999). Drawing on these studies, Information Systems scholars are critical of standardisation efforts, and emphasise that systems have to be adjusted to specific contexts of technology use. The notion of context is central here, and is understood as a rather restricted space, limited to individual engagements with technology, the broader community or a geographical site (Orlikowski, 2000; Suchman, 2007; Vaast & Walsham, 2009). It has been emphasised that every context is unique due to specific historical, social or technological arrangements. As a result, individuals or communities provided with the same technology would construct different interpretations and different work practices. IS scholars have constructed in-depth empirical narratives and provided a repertoire of analytical concepts which portray how technologies are used in specific contexts. Notions of workaround (Gasser, 1986), appropriation (Orlikowski, 1992a), and enactment (Orlikowski, 2000) emphasise the individual engagement with technology in addition to divergent and changing patterns of technology use. In short, the logic of standardisation, centralisation and control that is embedded in enterprise systems clashes with perspectives, which argue for contextual diversity. Consequently, it is argued that enterprise systems do not account for organisational diversity and produce "misfits" that subsequently invoke workarounds or require more formal changes in the enterprise systems (Boudreau & Robey, 2005; Soh, Kien, & Tay-Yap, 2000).

## 1.2 Research questions

Given the widespread consensus across industries to exploit integrated systems, although current theoretical discussions say that such systems do not account for organisational diversity, this thesis has the following overall purpose:

> *To investigate how integration efforts unfold in a large organisation and to characterise how working integrated systems are established in practice.*

More specifically, the following research questions are asked:

> **RQ 1:** How do users enact the same integrated system in different contexts, and what are the effects of local enactments?
>
> **RQ 2:** What are the dynamics of an integrated system implementation, and how does it influence organisation-wide integration efforts?

[1] Science studies are considered an interdisciplinary research field interested in how social and political aspects shape the development of scientific knowledge. In particular, Information Systems scholars have been influenced by these studies, which emphasise the social shaping of technology.

The first theme of this thesis aims to investigate how users enact integrated systems, what problems and challenges they encounter and what strategies they use to resolve the challenges. Similar to social studies of IS, our aim is to capture local activities, but we are also aiming to identify the consequences of local enactments. Moreover, we aim to understand work practices which span multiple contexts and are supported by multiple integrated systems. The second theme of the thesis is more analytical and aims to characterise the dynamics of an integrated system implementation and the various perspectives on integration in large-scale contexts. As a whole, the thesis has a strong focus on understanding collaborative work practices in a large-scale heterogeneous organisation.

## 1.3 Theoretical approach

This thesis is motivated by social studies of IS, yet also seriously considers the practical concerns related to the establishment of large-scale integrated IS. In order to identify a possible path for solving the existing dichotomy of local-global, the thesis draws on current discussions within the Information Systems field on the mediating role of integrated technologies (Pollock, Williams, D'Adderio, & Grimm, 2009; Vaast & Walsham, 2009) and more specifically on texts from science studies on standardisation (Berg & Timmermans, 2000; Timmermans & Berg, 1997), multiplicities (Mol, 2003), and cross-contextual work (Turnbull, 2000).

IS scholars recently recognised that social studies of IS have produced an in-depth understanding of how technologies are enacted in local contexts, yet devoted less attention to understanding the technological constraints across these contexts (Ellingsen & Monteiro, 2006), the longitudinal socio-technical transformation process (Kallinikos, 2004) and how materiality is intertwined with human agency in general (Leonardi & Barley, 2008; Orlikowski & Scott, 2008). The thesis relates to these concerns and considers technology development, implementation and use as an accomplishment of a network of material and social actors (Monteiro, 2000).

In particular, the thesis aims to investigate integrative technical details. Since information infrastructure studies were established to integrate multiple elements into a working infrastructure, a certain amount of standardisation efforts have to be carried out (Rolland & Monteiro, 2002). Standardisation efforts, however, are longitudinal and can hardly end up with universal standards (Berg & Timmermans, 2000; Timmermans & Berg, 1997). More importantly, establishing a working infrastructure implies an understanding of not just a local context, but rather of relationships and interactions between different contexts (Hanseth, Jacucci, Grisot, & Aanestad, 2006).

The thesis aims to synthesise these different approaches and develop a theoretical framework to help in analysing and understanding integration efforts in large-scale organisations. Four perspectives on integration are outlined: i)integration through standardisation, ii)reflexive integration, iii)integration with boundary objects and spanning activities, and iv)integration on demand. The proposed perspectives aim to go beyond existing dichotomies of loose-tight or social-technical integration and recognise that large-scale organising involves multiple forms of integration, which run in parallel and interact.

## 1.4 Research setting and approach

The research presented in this thesis draws from a longitudinal interpretive case study of recent efforts to establish a better integrated collaborative infrastructure in an international oil and gas company (OGC). Since the 1990s, the OGC has made significant efforts in establishing a corporate-wide collaborative infrastructure based on Lotus Notes. With the goal of establishing a better integrated collaborative infrastructure, significant changes were aimed by implementing a new system for collaboration (MS SharePoint), information retrieval (a corporate-wide search engine and the metadata standard) and document archiving (MS Meridio). It is the primary aim of this thesis to investigate the ongoing transformation of the collaborative infrastructure. Employing qualitative data collection methods such as interviews, observation and documentary evidence, the collected data cover four themes: i) technology development and management, ii) technology use in an R&D unit, iii) collaborative practices within oil and gas production, and iv) work practices during the planning of light well interventions. The research setting and approach are elaborated on in Sections 3 and 4, respectively.

## 1.5 Contributions

This thesis provides rich insights on how working integrated technology is established across different organisational contexts. Additionally, the thesis proposes a cross-contextual perspective on integrated systems use. As opposed to largely local, independent contexts of enacted technology, the use of integrated systems implies the interdependent enactment across the contexts now linked as a result of integration. Moreover, we develop a dynamic perspective on integration which, in contrast to technical approaches to integration or boundary object perspectives, emphasises the temporal and performative aspects of integration. Finally, this thesis provides practical implications for managing ingenerated systems.

## 1.6 The structure of the thesis

The remainder of the thesis is structured as follows: Section 2 outlines the theoretical perspectives that were adopted during this research. Section 3 presents the oil and gas company, research sites and ongoing changes in the collaborative infrastructure. In Section 4, research methods and data collection activities are outlined, and Section 5 presents the results based on all five papers. In Section 6, the implications are outlined, and the thesis is concluded in Section 7.

# 2 Theoretical approach

## 2.1 The practice turn – rejecting technological determinism

The new technologies invented during the Industrial Revolution led to dramatic increases in production capacity and, in this context, a belief that technology is a key governing force in society emerged (Smith, 1994). This view is defined as technological determinism and holds that “material forces, and especially the properties of available technologies, determine social events” (Sismondo, 2004, p.79). The notion of technological determinism was coined by Thorstein Veblen, an American economist and sociologists, who analysed how technology increased business performance. Recent studies provide a more diverse interpretation of the notion technological determinism. In particular, it was suggested that technological determinism can be understood as a spectrum ranging from “soft” to “hard” determinism (Smith & Marx, 1994, p.ix-xv). “Hard” determinism implies that technology determines the social organisation, while “soft” determinism holds that technology enables rather than imposes a social change.

Technological determinism[2] was, in particular, challenged by science studies that were interested in understanding the relationship between society and technology. Science scholars argue that technological determinism is an oversimplified cause-effect theory of historical change (MacKenzie & Wajcman, 1999, p.4). In particular, several studies illustrated that technology development does not depend on the individual inventor (or ‘genius’), and that technology, economics, politics and society are not discrete entities but rather intertwined (Pinch, Bijker, & Hughes, 1987). In short, science scholars demonstrated that technology is not an independent force that has foreseen consequences but rather that technology development and diffusion is an intertwined socio-technical process where many actors shape the trajectory in intended and unintended ways.

One of the key contributions in science studies was made by Pinch and Bijker (1987) when developing the notion of interpretive flexibility. Instead of attributing deterministic power to technological artefact, Bijker (1992, p.76) suggested that every artefact is “interpretively flexible”, meaning that “for different social groups, the artefact presents itself as essentially different artefacts”. From such a perspective an

[2] Science studies and information systems scholars rarely distinguish between different types of technological determinism, yet their critique is focused on “hard” technological determinism.

"artefact" is never the same since the meaning changes according to contingent situations. Another key contribution is developed by Lucy Suchman[3], who similar to the above-mentioned studies challenged the ideas behind technological determinism. Suchman (2007, p.70) suggests that actions are not determined in advance, but rather are situated: "every course of action depends in essential ways on its material and social circumstances". From such a perspective, plans on how technology will be implemented and used cannot be taken for granted; plans can influence, but not determine situated actions.

Science scholars reject technological determinism, and as Shapin (1995, p.304) vividly outlines "show in concrete detail the ways in which the making, maintenance, and modification of scientific knowledge is a local and a mundane affair". Drawing on science studies, information systems (IS) scholars also emphasised the need to explore human agency in order to develop better explanations in relation to why, how and with what consequences ITs are implemented and used:

> Lack of attention to the human and organizational aspects of IT is a major explanatory factor (with regard to the high levels of systems failure) and is manifest in poor management generally, poor project management, poor articulation of user requirements, inadequate attention to business needs and goals, and a failure to involve users appropriately (Clegg, et al., 1997, p.856)

As a recent literature review illustrates key contributions published in the *Information Systems Research* (ISR)[4] journal tend to black box the IT artefact, and either refer to it in passing or treat it as a discrete technical entity (Orlikowski & Iacono, 2001). As a result, Orlikowski and Iacono (2001) argue to a large extent that an IT artefact, which is at the core of the IS field, is under-conceptualised and researchers should account for its socio-technical aspects in order to develop more dynamic perspectives on how technologies are developed, used and maintained. Despite the fact that a large majority of the studies in the IS field do not analyse IT artefacts from a socio-technical perspective (Orlikowski & Iacono, 2001), a growing body of literature, which can be characterised as the Social Study of Information Systems[5] (SSIS), has emphasised the reciprocal relationship between human agency and technology. In turn, the primary aim of the following literature review sections is to analyse what

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[3] Lucy Suchman has narrower focus than science study scholars and in particular aims to conceptualise human computer interaction. In this thesis, her work is related to science studies, yet her contributions are published in a range of different fields, such as information systems and organisation studies.

[4] ISR is ranked among the top journals in the information systems field.

[5] A label used by Pollock and Williams (2009) and Kallinikos (2004).

methods are embraced and theoretical conceptualisations are developed by SSIS scholars.

## 2.2 The social study of IS - accounting for contextual richness

As mentioned above SSIS is influenced by the science studies in general and more specifically various theoretical perspectives from actor-network theory (Monteiro, 2000; Walsham & Sahay, 1999), structuration theory (Barrett & Walsham, 1999; Orlikowski, 2000), ethnomethodology (Suchman, 2007), and activity theory (Nardi & O'Day, 1999) were embraced. While these theoretical positions differ, they all urge the development of an in-depth understanding of actors (social and technical) and their interactions in a given site. For SSIS a central actor is a user[6] and empirical inquiry tends to focus on users' interaction with a system.

An early and influential contribution is Gasser's (1986) study of users' strategies of fitting, augmenting and working around the intentions inscribed into the functionality of a system. Gasser (ibid.) empirically illustrated what people actually do when confronted with rigid and unreliable computing procedures. Gasser (ibid.) vividly portrayed that users do not in fact use IS as they are designed, but invent various ad hoc strategies to fit the technology for a particular task. The major conceptualisation from this study was the notion of workaround, which refers to "using computing in ways for which it was not designed or avoiding its use and relying on an alternative means of accomplishing work" (ibid., p.216).

Similar to Gasser's work (1986), many studies have employed the notion of appropriation, which captures the importance of human action and the situated use of technology (Orlikowski & Robey, 1991). This perspective suggests that designers inscribe certain structures into technology and users subsequently engage in the process of appropriating these structures (Orlikowski & Robey, 1991). During the appropriation process users do not necessarily appropriate what was intended, and might use technology differently or not use it at all. More recently, Orlikowski (2000) proposed a "practice lens", which suggests that rather than starting with structures embedded in technology, one should focus on "human action and how its recurrent engagement with a given technology constitutes and reconstitutes particular emergent structures of using the technology" (ibid., p.421). In contrast to an appropriation perspective, the "practice lens" allows even more freedom for human action as "every

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[6] Actor-network theory inspired studies differ in this case as they consider technology as an important actor.

engagement with a technology is temporally and contextually provisional, and thus there is, in every use, always the possibility of a different structure being enacted" (ibid., p.412).

Methodologically, SSIS scholars adopt interpretive rather than positivist research tradition (Orlikowski & Baroudi, 1991) and inductive rather than deductive reasoning. Grounded theory (Orlikowski, 1993) and ethnography-informed (Schultze, 2001) research methods were identified as relevant approaches to explore IS implementation activities in real-world contexts and build theoretical perspectives on empirical data rather than analytical constructs. In particular, the need to explore users' perceptions (Orlikowski & Gash, 1994) and interactions with technology (Joshi, Barrett, & Walsham, 2007) were stressed, as these aspects determine how technology is used and can provide insights on how it should be improved. In order to develop an in-depth understanding on how technologies are used, researchers are required to spend a significant amount of time on-site. As a consequence, empirical data collection activities are limited to one or few events or actors.

For example, Orlikowski (1996) conducted a study in an organisation with 1,000 employees, yet data collection and analysis were limited to a customer service department with only 53 persons. On the other hand, Barley (1986) conducted a comparative study on how identical computed tomography scanners are used in two radiology departments. Barley (ibid.) analysed technology as a social rather than technical object, resulting in the occasioning of different organisational structures, as one department becomes far more decentralised.

Quite often, in-depth insights of how work is organised into a specific context are confronted with more formal procedures such as work descriptions or specific plans. Numerous empirical examples vividly demonstrate that formal procedures do not or cannot account for contingent and changing practices. In turn, a distinction between formal and informal practice was made. Similarly, the notion of "invisible" work was also proposed in order to account for work practices which are essential for completing a specific task, yet are not formalised (Bowker & Star, 1999).

The practical implications stemming from the social study of IS suggest that it is difficult, if even possible, to influence or control the trajectory of technology diffusion, despite the fact that managers or designer agenda users influence the trajectory of technology to a large degree. Orlikowski (1996), for instance, developed an empirically grounded situated change perspective, which emphasises improvisation and continuity over the planned or punctuated change models:

> Organization transformation is not portrayed as a drama staged by deliberate directors with predefined scripts and choreographed moves, or the inevitable outcome of a technological logic, or a sudden discontinuity that fundamentally invalidates the status quo. Rather, organizational transformation is seen here to be an ongoing improvisation enacted by organizational actors trying to make sense of and act coherently in the world. (Orlikowski, 1996, p. 65)

In a similar manner, but with a stronger focus on the technological infrastructure, Ciborra (2002, p.85) proposed a concept of "drift", which describes:

> A slight or sometimes significant, shift of the role and function in concrete situations of usage, compared to the planned, pre-defined, and assigned objectives and requirements that the technology is called upon to perform (irrespective of who plans or defines them, whether they are users, sponsors, specialists, vendors, or consultants).

The notion of "drift" was also confronted with more instrumental perspectives on large-scale technologies that are implemented and used in practice. Both theoretically and empirically, Ciborra and associates (2000) argued that managers' intentions to increase control with IT will lead to the opposite effect – less control.

## 2.3 The social study of integrated IS – accounting for technology misfit across contexts

### 2.3.1 Contextual influences on enterprise systems

During the last decade there has been an ongoing shift from small and specific-purpose oriented IS to large-scale integrated and standardised enterprise systems. As Pollock et al. (2003, p.318) have suggested, enterprise systems:

> Are so widely diffused that they now commonly described as the de facto standard for the replacement of legacy systems in medium- and large-sized organisations, and it said that some companies find impossible to work without one.

The transition to enterprise systems is especially visible in large-scale, geographically distributed organisations. These organisations can be characterised by a great number of geographical locations and the collection of heterogeneous technologies that contrast work practices, overlapping disciplines and various institutional structures. Historically, large organisations have developed a number of systems either for a specific geographical location or specific discipline. As a consequence, IT departments have continually suffered with a difficulty to manage a great number of incompatible and sometimes overlapping systems. According to Davenport (1998), managing multiple IS "represents one of the heaviest drags on business productivity and performance" (Davenport, 1998, p.123). As a result, enterprise systems were designed with the intention of solving the problem of the fragmentation of information across multiple systems. Integrating data into a single repository entails the standardisation of data and processes across various organisational contexts (Volkoff, Strong, & Elmes, 2005). In that sense, enterprise systems impose a centralisation and control over information (Davenport, 1998).

The introduction of enterprise systems introduces new challenges not only for organisations, but also for IS scholars as well. The current literature either develops better recommendations for controlling the implementation process to achieving planned results (Mendoza, Pérez, & Grimán, 2006; Nah, Lau, & Kuang, 2001) or aims at exploring ongoing changes associated with technical and social environments. Considering the latter stream, ongoing socio-technical changes are studied with previously embraced methodologies and developed perspectives on how IS are developed and used (see the previous section). Due to an inability to study "the entire" organisation, it has been divided by various boundaries such as geographical or organisational units, which have become an empirical basis. Thus, methodologically, in-depth case studies and ethnographies were embraced. Since every organisational context has its own history and socio-technical peculiarity, the tension of having a global technology which would accommodate local contingencies while at the same time being generic enough to span across a number of different contexts has been emphasised. Thus, practice-based, research on enterprise systems challenges the ambition of unity and spells out the situated character of local enactment of enterprise systems (Boudreau & Robey, 2005; Chu & Robey, 2008; Wagner & Newell, 2004).

For instance, Boudreau and Robey (2005) have shown how despite the rigidity of the ERP system, users are working around the system in unintended ways. They argue that users first avoid the system (due to inertia), later learn by improvising (rather than in formal training) and finally reinvent the system in unplanned ways. Thus, the authors emphasise the human agency perspective over technological logic and argue that "technology's consequences for organisations are enacted in use rather than embedded in technical features" (ibid. p.14). Likewise, Joshi et al. (2007) focus, to a large extent, on human agency and use of third-generation activity theory to analyse how two global organisations balance standardised approaches against diverse needs. Joshi et al. (ibid.) exemplify multiple viewpoints, contradictions and expansive cycles, and argue that the global reach of the systems is limited by such factors as local relevance and cultural fit.

One of the key theoretical conceptualisations developed when studying the use of enterprise systems relates to the notion of misfit proposed by Soh, Kien et al. (2000). The authors developed the notion of misfit to confront the logic of standardisation against organisational diversity. The authors have identified three types of misfits, namely, data, functional and output, and have argued that inscribed intentions originating from a Western context fail to fit into a public organisation in Southeast Asia.

### 2.3.2 Cooperative work across information spaces

The ways in which collaborative technologies are diffused in various settings is a widely discussed topic within Computer Supported Cooperative Work (CSCW) literature.[7] A combination of synchronous and asynchronous collaborative systems was proposed with the intention of supporting distributed activities across time and space dimensions. Early CSCW contributions made an explicit distinction that collaborative systems are multiple- rather single-user applications. In his seminal paper, Grudin (1989) argued that an automatic meeting scheduler can only work efficiently if everyone involved maintains a personal calendar. For this reason, collaborative work should be based on an agreed upon set of rules for interaction (Mark, 2002). However, in a manner similar to perspectives presented in previous sections, collaborative technologies were conceptualised as being fragile (Ciborra, 1996), and when they fail or do not meet expectations, users tend to switch to other nearby alternative media. Indeed, the core findings of CSCW literature suggest that "users appear to use groupware in another way than intended by its designers or as expected by IT departments". In that sense, it has been argued that collaborative systems should be flexible and "encourage unanticipated and innovative patterns of use" (Andriessen, Hettinga et al. 2003, p.367). Therefore, much the same as enterprise systems, collaborative systems are faced with the challenge of achieving uniformity, yet maintaining flexibility. In particular, such a challenge is addressed in studies on common information spaces (CIS).

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[7] SSIS and CSCW literature does overlap, as both research streams draw on science studies and some researchers belong to both communities. CSCW literature, however, has greater connections to ethnomethodology and is more confined as it devotes significant interest to technologies that support cooperative work.

The concept of common information spaces (CIS) was originally formulated by Schmidt and Bannon (1992) as an alternative to the so-called "workflow" perspective, in which every actor's actions can be predefined in advance. The authors have drawn on Suchman (1987) and highlighted that in contexts in which continuous negotiation and problem solving is required, a "workflow" perspective fails to explain how work is done in practice. The authors have argued that cooperative work is not facilitated merely through access to information in a shared database, but also requires a shared understanding of the meaning of this information, as the information always has to be interpreted by human actors. While the interpretation and construction of a particular object's meaning is situationally dependent, and determined locally within a given context, the coherence is crucial: "in order for work to be accomplished, these personal, or local information spaces must cohere, at least temporarily" (Schmidt & Bannon, 1992, p.21).

Initially, the notion of CIS was conceptualised as being generic and applicable to both small and large settings (Bannon & Bødker, 1997), yet more recent accounts on CIS address the issues of commonality in large-scale contexts. As suggested by Randall (2000, p.17), because "we have to deal with issues that arise out of the complex historical and geographically dispersed range of information resources that might be in use in the large organisation, or indeed across different organizations", it is problematic to identify exactly what is common across various work practices. Recently, Rolland and Hepsø et al. (2006) have argued that the concept of CIS was not applied in large-scale contexts, and suggest that in such contexts CIS is not given and stable, but rather situated and malleable.

## 2.4 Summary of the SSIS

During the last two decades SSIS scholars have investigated how various technologies are developed and used in a range of different contexts. Despite the diverse technologies, ranging from specialised hospital technologies to enterprise-wide collaborative systems, scholars have generalised a rather common pattern, that technologies are developed and used differently in different contexts. These findings were revealed through in-depth case studies and ethnographies.

One way to explain the similar generalisation would require relating SSIS to science studies. SSIS draws on conceptualisations proposed by science scholars that emphasise human agency and, as a result, develop theoretical conceptualisations (for instance enactment Orlikowski, 2002) that tend to give an important role to users or even see the user in control. Another reason lies in the methodological guidelines and their application. In particular, ethnographic approaches urge that a significant amount of time has to be spent in a single site in order to obtain an in-depth understanding. Interpretive case studies, on the other hand, provide more flexible analytical guidelines, yet in practice the majority of social studies of IS have restricted empirical data collection activities to a single site.

## 2.5 Emerging cross-contextual lens

### 2.5.1 Consensus for exploring technology

As outlined in the previous sections, the social study of IS have demonstrated beyond any reasonable doubt the important role of human agency. It is important to note that theoretical models developed by the social studies of IS have also granted an important role to technology (Orlikowski, 1992a). In theory, there is a consensus that both social and material factors are equally important, yet in practice the SSIS devotes significantly less attention to exploring technology (Jones & Orlikowski, 2007; Leonardi & Barley, 2008; Orlikowski & Scott, 2008). The need for better conceptualisations and empirical illustrations of how technology is entangled in everyday practices has been repeatedly made (King & Lyytinen, 2006; Orlikowski & Iacono, 2001; Weber, 2003), yet there are few studies which successfully bridge the existing divide.

In general terms, the social study of IS has been criticised by devoting too little attention to the process of socio-technical transformation:

> Technology is not just an exterior force that encroaches upon local, technologically "unspoiled" contexts, though it may be used that way; most of the time, technology partakes in the constitution of local contexts and agents. (Kallinikos, 2004, p.144)

More specifically, the growing criticism towards the social studies of IS is coming from scholars interested in large-scale information systems. While the social studies of IS have primarily focused on one or a few sites during the implementation phase, the dynamics and evolution of artefacts have not been properly addressed:

> While being highly informative these studies [the social study of IS] tell us rather little about what we regard as one of the most important developments in the short history of corporate information systems: the shift from locally specific to generic systems (Pollock & Williams, 2009, p.5)

Scholars interested in standardisation processes which usually span multiple information systems have also suggested that there is a need for a finer grain analysis of “how and where IT restricts and enables action” (Monteiro & Hanseth, 1995). Rather than allowing excessive “interpretive flexibility” for human agents, it is important to explain the socio-technical process of convergence or even stabilisation.

In short, as Leonardi and Barley (2008) have recently suggested, it is important to account for technology without being deterministic about it. In order to address the above outlined gap in the SSIS, two slightly different research directions have been identified. The first explores the emergence of enterprise systems and the new mediating forms it allows, whereas the second employs a broader perspective and explores large-scale heterogeneous networks, i.e. the information infrastructures. This literature is reviewed in the next sections.

### 2.5.2 From single to multiple contexts – addressing the mediating role of technology

Research on enterprise systems is heavily influenced by the social studies of IS, which has resulted in similar findings as well. If previous notions such as workaround were restricted to a certain context as a result of an implemented enterprise system, workarounds have been performed across multiple and seemingly independent contexts (Boudreau & Robey, 2005). While empirical illustrations continue to document various problems or paradoxes related to enterprise systems, industry actors continue deploying a range of standardised (i.e. ERP or CRM) or custom enterprise systems. Hence, vendors enjoy an ever-growing customer base, yet IS theories suggest that such systems do not work as intended.

According to Pollock and Williams et al. (2007, p.257), the core problem of existing research is that it fails to explain the longer-term evolution of both artefacts and local contexts. In response to short-term and user-centric studies, Pollock and Williams (2009) propose an alternative, which they call The Biography of Artefacts Framework. This framework suggests that scholars should go beyond snapshot studies and employ multiple research modes in order to address the evolution of artefacts. From a methodological perspective, Pollock and Williams (2009) suggest studying how a class of artefacts evolves over time across sectoral or organisational boundaries. Drawing on a number of studies conducted over a period of almost 20 years, Pollock and Williams (2009) have vividly revealed how despite the critique, including their own, enterprise systems continue to make a big transformation within organisations.

While the framework suggested by Pollock and Williams (2009) aims to capture the evolution of an artefact or even a class of artefacts, the authors propose important methodological considerations for smaller/shorter case studies. According to Pollock et al. (2007, p.256), the majority of IS social studies were interested in how information systems "are 'imported' ('domesticated', 'appropriated' or 'worked-around') into user settings, while there is a comparative lack of emphasis on the reverse process through which an artefact is 'exported' from the setting(s) in which it was produced". Similarly, Kallinikos (2004) criticises localist studies and argue that large-scale systems should be understood as cross-contextual rather than local since development and subsequent use of large-scale systems is constrained by many interdependent actors.

In a recent study, Vaast and Walsham (2009) also show the importance of studying multiple contexts, and have studied distributed communities of practice in the field of Environmental Health. Vaast and Walsham (2009) have also emphasised the role of technology, and coined the term "trans-situated learning" to explain how people can communicate and exchange experience with the help of technology, yet do not share an actual context in their work. While focusing on technical repairs Pollock et al. (2009) additionally analyse how new technologies allow networked forms of organising. The authors have studied how one of the largest packaged software producers in the world is providing customer support. In contrast to Orr's (1996) conceptualisation that technical repair is bound to local contingencies, Pollock et al. (2009) empirically illustrate how new technologies, in this case an online portal for customer support, allowed the move of technical repairs online:

> If the study of repairs has been characterised in the past by notions such as rooted and embedded problems and localised situations, it should now be augmented with those of disentangling, exporting and the globalised and extended situations. (Pollock, et al., 2009, p.274)

While enterprise technologies allow new forms of organising, scholars have also become concerned with what constraints such systems can produce. Given that enterprise systems aim to establish integration by standardisation, Ellingsen and Monteiro (2006) illustrated how a standardised module serving multiple laboratories of a hospital was tailored for a clinical-chemical laboratory, yet simultaneously became less suitable for a microbiology laboratory. Consequently, if a standardised enterprise systems is extensively tailored to a particular user community, it can becomes less suitable for other communities.

### 2.5.3 Transition from systems to infrastructures

Another research stream, which aims to complement the social studies of IS did not restrict the empirical or analytical focus to a system, but instead attempts to understand an information infrastructure (II) which is conceptualized as an “evolving shared, open, and heterogeneous installed base” (Hanseth, 2000, p.60). II is not a system with clearly defined boundaries, but rather a heterogeneous actor-network consisting of multitude interacting social and technical actors (Hanseth & Monteiro, 1998). II is a fundamentally relational concept (Star & Ruhleder, 1996), and can best be understood as enabling resources for action. Studies of II are inspired by science studies (T. P. Hughes, 1987) in general and Actor Network Theory in particular (Monteiro, 2000). II studies are diverse, but are quite often “tubes and wires”) enable certain practices. More importantly, however, even early accounts have emphasised the need for understanding how the process of how social and technical elements are assembled and negotiated in order to establish and sustain a network (Hanseth & Monteiro, 1997; Monteiro & Hanseth, 1995). A common interest among II scholars is to develop a better understanding of how to enable long-term information infrastructure development that can support information and knowledge sharing among multiple and changing communities (Baker & Bowker, 2007; Edwards, Bowker, Jackson, & Williams, 2009; Edwards, Jackson, Bowker, & Knobel, 2007). In turn, standards which enable the linking of multiple systems or communities were identified as the core element within an infrastructure (Monteiro & Hanseth, 1995).

An information infrastructure is a loose object without clear boundaries. Adding a new component implies extending and transforming the existing infrastructure. Because of this, it has been argued that information systems are never rolled out on a “green field”, but are an element in a network. Differently from SSIS, infrastructure scholars have emphasised not only the need to “fit” a system with a human agency, but establishing a new system that needs to be integrated with existing technologies as well. In that sense, establishing connections (i.e. integrating) across systems and communities is crucial in order for an infrastructure to function. II scholars promote an approach based on the idea of gateways (Hanseth, 2001) which function as “converter” that allow different systems or practices to co-exist. In practice, an II is a collection of diverse standards which enable various links across systems and communities. In contrast to SSIS, which analyses how a certain community adopts a system, II scholars are interested in multiple adoptions and interactions across communities or systems.

In order to explain such interactions, II scholars extensively draw on work by Timmermans and Berg (Berg & Timmermans, 2000; Timmermans & Berg, 1997). Timmermans and Berg (1997) studied clinical protocols as standards and showed that standards are not universal, as they do not account for various local contingencies. To the contrary, local tinkering does not undermine standards; such activities repair and adjust standards to unseen situations. From this perspective, standards are seen as "local universals" that depend on both universality and contingency. More recently, Berg and Timmermans (2000) illustrated how standardisation (i.e. ordering) in one context can simultaneously produce a certain disorder in another.

Influenced by these accounts, II scholars highlighted how ambitions to establish a large-scale standardised (i.e. universal) information infrastructure have led to diversity (i.e. local universal) (Hanseth & Braa, 2001). More importantly, given that II are connected networks, "local universalities" interacting and ordering activities in one context can produce disorder in another (Ellingsen & Monteiro, 2006). To summarise, II is prone to surprising side- or even domino effects (Hanseth, Ciborra, & Braa, 2001) which propagate across multiple systems.

To summarise, the concept of cross-contextual in a similar way as post local (Pollock, et al., 2009) or trans-situated (Vaast & Walsham, 2009) aims to explore non-local aspects of work and in particular to investigate interactions and interdependencies across multiple contexts.

## 2.6 Conceptualising the four perspectives on integration

Over the past decade, the notion of integration has been and continues to be an important motivating vision for organisations to achieve better connections among different disciplines and to improve information transfer across the value chains. It is assumed that integration is a prerequisite, as opposed to an option, for every large organisation. From a management perspective, integration is seen as a means for cutting costs and improving efficiency (Linthicum, 2004). Information redundancy and fragmentation are another "unwanted" phenomena (Davenport, 1998, p.123). Movements towards "seamless" integration are identified across various industries such as health care (Ellingsen & Monteiro, 2003), ship classification (Rolland & Monteiro, 2002), e-government (Ciborra, 2005), and the oil and gas industry (Hepsø, Monteiro, & Rolland, 2009). As one example, the petroleum industry is currently heavily investing in the establishment of so-called "integrated environments" (the Integrated Operations Initiative), which would allow the more effective sharing of knowledge between geographically distributed heterogeneous disciplines. According to the Norwegian Oil Industry Association, more integrated modes of working would allow the achievement of a much greater economic efficiency.[8] However, given a grand consensus and multiple initiatives across industries for achieving greater integration, the core questions of what exactly integration is and how to achieve it are highly debated.

A significant body of research has considered integration as a purely technological issue (Gulledge, 2006), and developed multiple levels of integration (Linthicum, 2004) and different approaches to integration (Hasselbring, 2000). Despite an existing variety of perspectives, approaches and methods, integration is complex and difficult to achieve in practice (Davenport, 1998; Linthicum, 2004). In order to develop a better understanding of the process and the consequences of integration, researchers have argued that a socio-technical approach should be employed (Ellingsen & Monteiro, 2006; Wainwright & Waring, 2004). Integration socio-technically implies the analysing of how cross-disciplinary work is conducted in practice. To achieve (at least temporally) integration implies resolving syntactic, semantic or pragmatic differences between disciplines (Carlile, 2004). In turn, the primary purpose of this section is to embrace the socio-technical approach and outline four perspectives on integration (see Table 1).

The four perspectives on integration do not outline an exhaustive classification. In that sense, the perspectives are separated for analytical purposes, and in practice, the boundaries between the perspectives can blur. The developed perspectives are closely related to empirical data gathered through this research project (see Section 2.7) as well as theoretical ideas presented in the previous sections.

Thus, the primary aim of the proposed perspectives is to expand the current discussions on integration efforts in large-scale organisations. Large-scale organisations do not follow a single line of logic, but instead can be described as having multiple modes of ordering running in parallel (Law, 1994). Similarly, large-scale organisations do not rely on a single perspective on integration, but employ (formally or informally) different perspectives in parallel. The different perspectives are not independent of each other, but do interact.

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[8]http://www.olf.no/io/

**Table 1 - Four perspectives on integration**

| Perspective on integration | Theoretical grounding | Characteristics | The context of application |
|---|---|---|---|
| Integration through standardisation | • Davenport (1998)<br>• Syntactic boundary (Carlile 2004) | • Eliminating differences by imposing standards<br>• Top-down approach | • When actors (disciplines, departments, etc.) collaborate often<br>• When syntactic precision is needed<br>• Implementation of standardised technologies (e.g. ERP) |
| Reflexive integration | • Hanseth and Ciborra (2007)<br>• Hanseth et al. (2006)<br>• Syntactic boundary (Carlile 2004) | • Side effects<br>• Reflexive dynamics – ordering can produce disorder | • Large-scale organisations establishing tightly integrated information infrastructures |
| Integration with common objects and spanning activities | • Star and Griesemer (1989)<br>• Semantic boundary (Carlile 2004) | • Bottom-up approach<br>• Sustaining contextual differences | • When interdisciplinary interaction is required and a common understanding needs to be established.<br>• Collaborative technologies (MSP, LN) |
| Integration on demand | • Mol (2003)<br>• Pragmatic boundary (Carlile 2004) | • Integration is rare and established on an ad hoc basis | • For actors working in a loose network. When interaction is rare and difficult to predict.<br>• Full spectrum of collaborative (synchronous and asynchronous) and specialised technologies. |

### 2.6.1 Integration through standardisation

As practice-based research has illustrated, people perform the same activity differently, i.e. with different tools in a different way (sequence or interaction), producing a different outcome. In addition, various disciplines usually rely on distinct technologies. For that reason, information about certain phenomena is usually fragmented, overlapping or even redundant. According to Davenport (1998), managing multiple IS represents a "drag" for organisations. One way to achieve integration is to attempt to eliminate fragmentation, overlaps, and redundancy. Such an approach requires standardising work routines and practices across multiple contexts and implementing centralised data repositories in order to "streamline the data flow between different functions in an organization" (Lee, Siau, & Hong, 2003, p.56). Various enterprise systems are developed to achieve such aims including Customer Relationship Management (CRM), Enterprise Resource Management (ERP) or collaborative ones (e.g. MS SharePoint or Lotus Notes).

This type of approach is usually initiated by management and called "top-down", as it imposes a generic standard, which quite often is different from existing practices.

Integration through standardisation builds on the assumption that in order to communicate efficiently, a common and standardised language has to be established. In turn, this approach is particularly relevant in more "stable" contexts, when interaction between certain disciplines is frequent and the novelty level is low (Carlile, 2004). Implementing a generic standard is usually a longitudinal and not necessarily successful process. As discussed in section 2.3.1, users can encounter multiple misfits which would require tinkering in order to adjust a system to a given situation. More recent studies on enterprise systems illustrated that an organisation-wide standardisation requires user involvement and may result in several alternative standards and not just a single one (Fleck, 1994; Pollock, et al., 2007). Vendors also acknowledge the need for multiple standards, as they are currently promoting not a single enterprise system, but a range of multiple enterprise systems which come in different versions (i.e. different modules, functionalities, and interfaces) and have extensive customisation possibilities.

### 2.6.2 Reflexive Integration

A reflexive integration perspective emerges in the context of large-scale heterogeneous networks, which are usually referred to as information infrastructures (see Section 2.5.3). II scholars argue that organisation relies on a collection of various ICTs. Moreover, these ICTs are not stand-alone artefacts, but become increasingly integrated. As a result, a network becomes a complex one, consisting of different types of components as well as links (Hanseth & Ciborra, 2007). In order to explain the dynamics of such a network, scholars draw on conceptualisations of complex systems (Perrow, 1999), reflexive modernisation (Beck, Giddens, & Lash, 1994), and recent developments in actor-network theory (Law & Mol, 2002). According to these conceptualisations, it is very hard to map all connections between components; thus, changing or adding a component can produce unwanted side effects across multiple networks. Consequently, it is difficult to control such networks (Ciborra, et al., 2000).

In particular, these conceptualisations were employed to argue against standardised enterprise systems (discussed in Section 2.6.1) or initiatives for establishing tight integration across systems in general. Scholars argued that information infrastructures have reflexive dynamics, thereby implying that intentions to eliminate fragmentation by standardising can be "reflected back" on initial aims which results in even more fragmentation (Hanseth & Ciborra, 2007). In a health care context, intentions to establish a standardised and integrated electronic patient record (i.e. a single standardised system) can lead to the opposite effect of a greater disorder and instability (Hanseth, et al., 2006). Therefore, the integration has a "double face": "it emerges as a reflexive process where integration initiatives aiming at increasing control and less fragmentation actually lead to an opposite unintended outcome and increased fragmentation, which in turn leads to other integration initiatives, and so on" (Hanseth, Jacucci, Grisot, & Aanestad, 2007, p.120).

In contrast to other perspectives of integration, reflexive integration aims to explain interactions across multiple systems and the effects they produce over time (Jarulaitis & Monteiro, 2009). In large-scale complex organisations such as hospitals or the oil and gas business, patterns of reflexive integration are difficult to avoid to a certain extent as multiple systems are integrated in order to establish better and easier informational availability.

### 2.6.3 Integration with boundary objects and spanning activities

As discussed in sections and 2.3, empirical research has developed an extensive critique on the assumption that work can be standardised by imposing generic standards across contexts. Rather than eliminating diversity with a common standard, scholars proposed the need to sustain and cultivate differences while at the same time developing tools and practices which would help to establish a common understanding. Star and Griesemer (1989) developed the notion of a boundary object, which in the context of IS is quite often referred to as a system. Such systems should then not impose a standardised work practice, but rather be "both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star & Griesemer, 1989, p.393). This perspective should be seen in sharp contrast to the above presented perspective on "integration through standardisation" as contextual differences and "bottom-up" practices are emphasised. This conceptualisation received significant attention across several communities. In II studies (see Section 2.5.3), boundary objects can be compared with gateways which function as converters between different networks. The CSCW literature (see Section 2.3.2) also developed a notion of Common Information Spaces that also heavily draw on boundary objects.

This perspective on integration aims to avoid the traps of too tight forms of integration, yet requires a continuous effort to maintain a common understanding of the participants involved. In order to bridge different communities, scholars emphasise not only the need for common objects, but also the need for active negotiation as well. This activity was particularly privileged to so-called boundary spanners, which are individuals "who facilitate the sharing of expertise by linking two or more groups of people separated by location, hierarchy, or function” (Levina & Vaast, 2005, p.338).

In short, this perspective suggests that rather than standardising, multiple communities should be allowed to cultivate differences which can be smoothened by developing common boundary objects and engaging in boundary spanning activities. The relevance of this perspective was especially acknowledged when multiple communities were engaged in novel projects that require improvisation and creativity rather than predefined standard work procedures (Carlile, 2004).

### 2.6.4 Integration on demand

Integration with boundary objects or a reflexive perspective on integration argues against rigid forms of standardisation. Scholars have emphasised flexibility and loosely integrated networks as well as the importance of establishing a common understanding or shared meaning across multiple communities. Recent ANT-related accounts have taken this idea one step further to argue against a stable consistency, completeness, and non-redundancy.

Mol (2003) analysed how various medical disciplines are working around the same disease, and identified that different medical disciplines work independently, focusing on various aspects of the disease, employing different methods and using different tools. In turn, Mol (2003, p.6) argues for multiplicities rather than singularities: “differences are incompatible; there is not one object but multiple; objects are multiple and ‘make a patchwork’ (ibid., p. 72). In contrast to a boundary object perspective, Mol’s (2003) concept starts from the premise that different communities operate largely independently of each other. Multiplicities and differences across different disciplines do not imply chaos; to the contrary, according to Mol (2003), practices also hang together. In a sense of integration, compatibility is achieved only rarely on an ad hoc basis and only when required. Consequently, integration is rare, temporal and achieved on demand.

Only a few IS studies have employed this perspective in order to explain the collaborative practices among multiple communities (Grisot, 2008; Jarulaitis & Monteiro, 2010). Yet, we argue that this conceptualisation is particularly relevant for large-scale organisations in which it is difficult to predefine which communities and when will collaborate. Rather than investing in continuous efforts to establish common tools or a shared understanding (see Section 2.6.3), it is more cost-efficient to resolve inconsistencies on demand. This perspective on integration highlights the temporal and performative aspects (Law & Singleton, 2000) of integration. This perspective also differs from II studies, which promote slow changes, continuity and the cultivation of an installed base (see Section 2.5.3). “Integration on demand” emphasises discontinuities and punctuations.

## 2.7 Framework for analysing integration

The primary purpose of this section is to relate the above-developed perspectives on integration to the empirical case. The table below provides a brief insight on how the perspectives of integration manifest themselves in OGC:

| PERSPECTIVE ON INTEGRATION | EMPIRICAL ILLUSTRATION |
|---|---|
| Integration through standardisation<br>• Eliminating differences | OGC devotes a significant effort to establishing standardised work practices (in terms of work process descriptions), which are supported with standardised enterprise systems. MS SharePoint is a flexible technology, yet OGC has a standardised functionality and user interface in order to enforce standardisation efforts. An internally developed metadata standard is another example of standardisation efforts aimed at the syntactic level in order to establish a common lexicon (Carlile 2004). |
| Reflexive integration:<br>• Side effects | Integrating diverse information systems into an integrated information infrastructure relates to increasing availability and accessibility of information. OGC attempted to achieve this aim by implementing a corporate-wide search engine, which indexes information stored in multiple ISs such as Lotus Notes, MS SharePoint, Meridio (archive), intranet, and file servers. The side-effect of such integration relates to access management. A substantial side effect emerged not due to unavailability, but rather to the availability of large amounts of confidential information. Due to a tight integration with corporate search engines, the incorrect classification of documents made it possible for confidential information to be available to many more than it should have been. Since it was not possible to apply any “quick fix”, the search engine was suspended for 5 months, which was the period used to “clean-up” incorrect classifications and develop the approach that would prohibit such side effects in the future. |
| Integration with common objects and spanning activities<br>• Coordination activities | Oil and gas production relies on a strict division of labour, yet the success of the entire value chain depends on a multidisciplinary collaboration. Given that multiple disciplines work around the same object (a well), their activities have to be coordinated. OGC is heavily invested in establishing so-called collaborative rooms for supporting coordination between offshore and onshore personnel. Such coordination is supported with multiple technologies like Live Meeting for video conferencing, smartboards for real-time representation and discussion, in addition to shared screens for showing and discussing multiple specialised applications. A significant amount of such coordination is planned and takes place in certain cycles like every |

| PERSPECTIVE ON INTEGRATION | EMPIRICAL ILLUSTRATION |
|---|---|
| | morning/week/month. For instance, every morning production, process and reservoir engineers meet in a collaboration room to have a videoconference with personnel working in the platform's control room. The meeting lasts for up to an hour, which is the time needed to discuss the status and problems related to specific wells. Tasks that require a larger effort are planned, documented and assigned to certain disciplines during these meetings as well. |
| Integration on demand<br>• Intensive and temporal collaboration | While a significant amount of collaboration and coordination is a routine, certain events invoke ad hoc and temporal forms of collaboration. For example, when particular equipment installed in the well breaks down, it has to be replaced. Production engineers, who observe production performance would initiate a well intervention, although it is planned and conducted by well engineers. Additionally, well engineers have to collaborate with vendors and service companies in order to develop broken equipment and to assemble the required socio-technical network (expertise and required equipment) for performing this intervention. While some interventions are "standard", others have an element of novelty; thus, the multiple disciplines involved in the well intervention have to discuss and negotiate how to perform the intervention in a safe and cost-effective way. In these types of situations, integration is rare, temporal and achieved on demand. |

# 3 Case

## 3.1 Oil and Gas Company

The Oil and Gas Company, (OGC a pseudonym), was established in the 1970s and since then has grown to a global energy company, currently employing some 30,000 people with activities in 40 countries across 4 continents. The OGC has grown organically and includes several acquisitions and mergers. Recently, the OGC diversified and expanded its shareholder ownership to include becoming listed on the New York Stock Exchange (NYSE). As a result, the company is governed by external requirements related to country-specific laws, regulations, and NYSE requirements. In addition, the OGC has developed extensive internal principles and regulations.

The OGC has a long history of organising work according to hierarchical models and a strict division of labour. Currently, the OGC can be classified as a matrix organisation. The organisational chart splits the OGC into business units which are responsible for particular functions. As result, oil and gas production from a particular oil and gas field is dependent on a number of different engineering disciplines belonging to different functional units. Additionally, the OGC is heavily invested in establishing and continually improving core business processes that describe how certain activities must be executed. The primary purpose of these process models is to "ensure standardisation and deployment of best practice" (internal OGC documents). As result, oil and gas production should be performed according to the same process irrespectively of geographical location. Each process is divided into smaller ones, yet the level of granularity and detail varies. Core processes such as drilling and well maintenance are described in extensive detail. Process descriptions outline the sequence of activities, actors' involved, required deliverables and references to other governing documentation. Another organising principle employed by the OGC is the co-location of different engineering disciplines, which are responsible for activities in a particular oil and gas field. In addition to internal matrix organising, the OGC is heavily dependent on multiple external vendors and service companies. The OGC is continually investing in various expertise areas, yet its core competence is the operation of the entire oil and gas value chain.

## 3.2 Establishing an integrated collaborative infrastructure

### 3.2.1 Diffusing MS SharePoint

Aside from its growth in size in the geography and business area, the OGC has been engaged in a number of corporate initiatives in order to improve the collaboration within and across disciplines. These initiatives have relied heavily on the use of information systems. The first comprehensive effort to establish a corporate, collaborative infrastructure in this regard took place in the early 1990s at a time of recession in the oil industry amidst falling oil prices and low dollar exchange rates. The centralisation, standardisation and market-orientation of IT services were the direct outcome of several projects whose primary aim was to solve the problems of a fragmented and incompatible IT. The outcome of these standardisation activities led to the establishment of a collaborative infrastructure that used Lotus Notes.

The Lotus Notes infrastructure has proved successful inasmuch as it has been widely used for a range of different purposes. A key vehicle for facilitating collaboration within projects in the OGC has been the Lotus Notes Arena (hereafter known as the Arena) databases for the collective storing and dissemination of documents. However, the primary challenge for this infrastructure has been to promote communication across the project-defined boundaries of the Arena databases. The Arena databases had no central indexing functionality, meaning that one had to know in which database to search. With the existence of Arena databases that were apparently thriving “out of control” (there were estimated to be some 5,000 databases at the latest count), the location of relevant information stored outside the immediate scope of one’s own project was far from being a trivial matter. Each user also had access to both personal (F disc) and departmental storage (G disc) areas (i.e. file servers). To sum, information was scattered and duplicated over many storage areas.

In order to overcome the problems associated with Lotus Notes and to establish a more effective means of collaboration and experience transfer, the OGC formulated a new strategy in 2001. According to this strategy, although the OGC already possessed a set of general collaborative tools, “these tools [were] poorly integrated”, and “there [was] a particular need for better and more integrated coordination tools, as well as a better search functionality and improved possibilities for sharing information with external partners” (OGC strategy documents). Accounting regulations (i.e. SOX) enacted in the aftermath of the Enron scandal increased the pressure to ensure a more systematic and consistent documentation of business decisions to better inform the stock market and public at large. In that sense, comprehensive changes in the collaborative infrastructure were also seen as a means to achieve compliancy with SOX requirements.

The selection of the technology that would support this new collaborative strategy followed a long process. The process was planned according to best practices and executed in a step-by-step manner. A feasibility study was carried out in late 2002. During 2003, several solution scenarios were developed in terms of requirements specified and vendors selected. In December 2003, a contract with a vendor was signed while at the beginning of 2004, the first pilot using an MS SharePoint out-of-the-box solution was launched. Early experiences of this technology evoked multiple user requests for improvements. In addition, numerous technical components had to be developed in order to achieve a better integration between MSP and the existing installed base systems. By the end of 2004, the version 1.0 was released, but nonetheless, multiple improvements were again required. While MS SharePoint is a customisable technology, the OGC decided to make the solution as generic as possible so that it would fit all contexts (internally, it is referred to as a "one-size-fits-all" strategy). For this reason all TSs which are used for document storage and dissemination have a common interface and functionality. The beginning of 2005 saw the release of version 1.1 and as one manager explained, "we were ready to roll out the solution". The "roll-out" process was fairly fast, and by the end of October 2005 the final 5,000 users had been added. The technical part of the diffusion (i.e. adding some 25,000 users to the new system) was therefore largely problem-free and took less than a year.

### 3.2.2 Towards integrated collaborative infrastructure

The diffusion of MS SharePoint implied a phasing out of Lotus Notes. The initial plan stated that "within the end of 2008, new solutions [MS SharePoint] will be introduced and all Arena databases replaced and/or removed" (OGC intranet). Replacing and removing Arena databases, however, proved to be more challenging than expected. The first challenge was related to several longitudinal projects that were started a while before the implementation of MSP. Since these projects had accumulated a large amount of documents, they were allowed to continue working in Arena databases. Another challenge for MS SharePoint was to become a central collaborative system, which relates to certain restrictions of MSP. Until recently, MSP did not support documents with macros, yet such documents are of high importance for various engineers working with production optimisations. For this reason, file servers had to be used for these documents. Additionally, an MSP file size restriction was set at 100MB, yet some files produced with specialised systems can exceed 1GB. Such documents also had to be stored in file servers. Another, but more significant challenge relates to the automated transfer of documents. Several pilots attempted to transfer documents from Lotus Notes, though due to large amounts of documents and different ways of organising them "the results were disappointing, as it was very difficult to find documents afterwards". As of now (i.e. 2010), the transition has been finished, and Lotus Notes and file servers are actively used in tandem with MSP.

In addition to the collaborative systems outlined above, the OGC recently implemented a centralised archive solution based on MS Meridio, which also reflects an ambition to improve compliancy with SOX requirements. Other systems that are part of the collaborative infrastructure include intranet, MS Exchange and a system for storing internal governing documents. In order to enable information retrieval across various collaborative systems, the OGC has also implemented a corporate wide search engine, which indexes documents stored in all of the above outlined systems.

With the intention of further improving information retrieval and retention practices, the OGC internally developed a metadata standard. The metadata standard is a classification used to tag documents stored in MSP. The metadata standard was developed in collaboration with the MSP project team, Record Information Managers and process owners (PO). RIMs would define and maintain the metadata structure, whereas POs would primarily be responsible for developing the values of the metadata. The structure of the metadata standard was inspired by the Dublin Core Metadata Initiative (DCMI), though the OGC made significant customisations. While the metadata standard represents 13 elements and less than 100 sub-elements, our analysis focused on those elements that had to be assigned manually by users. The metadata standard can be considered as an integrative element within the collaborative infrastructure. The metadata is an embedded element in MSP, but is also utilized by the corporate-wide search engine in order to improve information retrieval by providing various filtering functionalities.

To summarise, the OGC has made a comprehensive effort to establish an integrated collaborative infrastructure, which would help to achieve compliance regulations (i.e. SOX), as well as improving information accessibility and sharing practices internally in the organisation and with external partners.

## 3.3 Research settings

The intentions behind a new collaborative infrastructure and user experiences were studied in several organisational contexts. The technological complexity, implementation process and future plans of a collaborative infrastructure were discussed with developers, administrators and managers of the IT infrastructure. Most of these individuals are formally related to the IT department, yet do not represent a homogeneous group, as they work with different elements/aspects of the collaborative infrastructure. Conversations with these individuals were particularly intense at the beginning of the data collection.

The collaborative work practices were studied in three different organisational contexts, namely, Research and Development (R&D), Oil and Gas Production (OGP) and Light Well Interventions (LWI).

R&D is an organisational unit that conducts research in special laboratories within the fields of materials technology, energy and environmental analysis, oil refining, gas and oil processing, gas conversion and petrochemicals, and biotechnology. Other research covers “softer” issues including, for example, the analysis of work practices in order to improve collaboration. Some research projects are conducted in specific areas (such as the one mentioned above), while in other cases research projects are innovative and may cut across a variety of disciplines. My understanding of R&D is based on multiple conversations with various engineers and intensive collaboration with researchers investigating work practices. In this context, I mainly studied user’s engagement with the collaborative infrastructure in general, and metadata use in particular.

OGP is a distinct and core business unit within the OGC. Oil and gas production may be characterised as an interdisciplinary, heterogeneous and distributed work activity. The oil and gas value chain spans such activities as exploration, well drilling and the optimisation of production. The central object in OGP is a well. Geophysicists, petrophysicists and drilling and reservoir engineers are all involved in the planning of new wells. While drilling engineers primarily control the drilling, production engineers observe well performance and initiate well interventions during production, which are then performed by well engineers. These activities are interdependent and distributed in time and space as the different disciplines work with the same well over a period of many years. I have interviewed and observed various engineers regarding the use of this collaborative infrastructure and the work practices around a given well.

While exploring this organisational context, I have broadened my empirical and analytical focus in order to understand the core oil and gas activities.

Light well intervention activities are part of the overall oil and gas production, although in this thesis it is considered as a distinct context since its work practices are quite unique. Traditionally, wells are drilled, completed and maintained from a platform, and these wells are called topside. Since the late 1980s, the OGC has been increasingly investing in so-called subsea wells, which are completed on the seabed and accessed (i.e. drilled, completed and maintained) with mobile platforms or vessels. Currently, the OGC operates approximately 500 subsea wells, which are distributed across many oil and gas fields. The maintenance of topside and subsea wells differs. The same group of well engineers usually maintain topside wells connected to a particular platform over a long period of time. On the other hand, a small community of well engineers maintains all the subsea wells. As a result, maintaining subsea wells implies working across multiple oil and gas fields. Light well interventions denote smaller subsea well interventions, which do not a need a mobile rig yet can be performed from a vessel. The growing number of subsea wells automatically translates into increasing maintenance activities. In 2006, the OGC established a “Light Well Intervention” department, which currently consists of 30 people who are responsible for planning and operating well interventions. The empirical data collected in this context primarily investigates the challenges related to planning well interventions across different oil and gas fields.

# 4 Research method

## 4.1 Research approach

The aim of this thesis was to investigate how integration efforts unfold in a large organisation. Methodologically, the research is framed as an interpretive longitudinal case study. In contrast to a positivist tradition, which depends on hypothesis testing, quantifiable measures of variables and objective and factual accounts, the interpretive tradition aims to:

> Increase understanding of the phenomena within cultural and contextual situations; where the phenomenon of interest was examined in its natural settings and from the perspective of the participants; and where researchers did not impose their outsiders a priori understanding on the situation. (Orlikowski & Baroudi, 1991, p.5)

While a positivist tradition assumes "that reality is objectively given and can be described by measurable properties" (Avison & Myers, 2002, p.6), the ontological position of interpretive research is that the social world is not a "given", but is constructed through language, meanings and artefacts (Klein & Myers, 1999). From an epistemological viewpoint, interpretive tradition embraces rather than aims to eliminate a researcher's bias and emphasises the importance of engaging in the world in order to explain it. This interpretive tradition can thus be seen as a rather flexible research approach, one that is particularly relevant for longitudinal explorative studies in which the research focus is not predefined, but rather can be adjusted depending on the circumstances and emerging analytical patterns.

While often juxtaposed, an interpretive stance should not be seen as a better methodological approach to study organisations. Different approaches are required in order to highlight different aspects of the same phenomena. Scholars have not yet developed approaches on how a positivistic and interpretive stance can be combined, though a number of researchers have started to combine qualitative and quantitative data in order to focus on multiple aspects of the same phenomena (see for instance Lærum, Ellingsen, & Faxvaag, 2001). One of the major critiques of interpretive research is that such studies are mere "reportages and local narratives" (Carlsson, 2003). The relevance of fascinating empirical detail, which is typical for interpretive studies, should be critically valued to avoid "ethnographic positivism":

> Where empirical data that are basically fabricated by the researcher's orientations, perceptive biases, and methods are taken as the ultimate yardstick

> of assessing reality - at the same time as important, but not immediately observable, aspects of reality are ignored. (Kallinikos, 2004, p.145)

Similarly, Pollock and Williams (2009, p.12) suggested that empirical work should be "strategically" motivated in order to uncover "the technology/society relationship at multiple levels and timeframes". While agreeing with this critique, I share Walsham's (2005) view that "interpretivism" is a label which enables, rather than constrains, imaginative thought. Several methodological alternatives were proposed in order to improve research (see for instance Howcroft & Trauth, 2005), yet there are too few accounts which solve the problem of "reportages and local narratives". From that perspective, a method, in this case an interpretive case study is not seen as a set of tools ready to be applied. On the contrary, it is thought as a set of guidelines (Klein & Myers, 1999), which have to be mindfully integrated into the overall research project. The interpretive tradition was identified as being particularly relevant approach for the reported research as it emphasised (Walsham, 1995, 2006) : a) a varying style of involvement, b) different ways of using theory, c) a non-deterministic research plan, d) multiple data collection and analysis methods, and e) several possibilities for generalisations. These aspects are discussed in the following sections.

## 4.2 Data collection

Interpretive research encourages various data collection methods in order to obtain diverse perspectives (Klein & Myers, 1999) and to facilitate triangulation practices. The majority of interpretive case studies draws on qualitative data sources such as interviews, observation and documental evidence; however, Walsham (2006) argues that quantitative data can provide interesting insights as well. Qualitative data were the primary data sources used during this project, yet I also had an opportunity to study search engine usage statistics, which served as contextual information for the analysis. In the following, the primary aim of this section is to outline data collection activities.

Data collection activities started at the beginning of 2007 with the main goal of exploring collaborative infrastructure and collaborative work practices in various organisational contexts. Three modes of data gathering were employed, namely the use of formal and informal interviews, observation and the use of documentary evidence (see Table 2 for a summary on what empirical data was collected in different organisational contexts).

**Table 2 - Data sources according to organisational context**

| ORGANISATIONAL CONTEXT | DATA SOURCES |
|---|---|
| Technology development and management | *Interviews*<br>• In total, 14 semi-structured interviews were conducted with developers, administrators and managers of the IT infrastructure<br>*Documents*<br>• Internal presentations explaining various elements/systems (metadata, search engine, MS SharePoint, Meridio, Intranet) of the collaborative infrastructure.<br>• Training materials<br>• Search engine statistics |
| Collaborative practices within Research and Development (R&D) | *Interviews*<br>• In total, 23 semi-structured interviews conducted with engineers and senior researchers<br>• Unstructured/informal interviews with engineers and researchers during coffee/lunch breaks<br>*Documents*<br>• Internal OGC documents outlining R&D work practices<br>• Intranet-based sources providing general information about R&D activities and news<br>*Observation*<br>• Passive observation of work practices in an open-plan office<br>• Participatory observations during five meeting related to an internal project for improving collaboration practices and fifteen 'status' meetings among senior researchers.<br>• Passive observations of MS SharePoint use |
| Collaborative practices within Oil and Gas Production (OGP) | *Interviews*<br>• In total, 22 semi-structured interviews conducted with drilling, well, production and process engineers<br>• Unstructured/informal interviews with engineers during coffee/lunch breaks<br>*Documents*<br>• Internal OGC documents outlining OGP work practices<br>• Intranet-based sources providing general information about OGP activities and news<br>*Observation*<br>• Passive observations of one meeting related to platforms technical condition and two meetings related to production optimisation |
| Collaborative practices during light well interventions (LWI) | *Interviews*<br>• In total, 9 semi-structured interviews conducted with well and subsea engineers and a well planning manager and health and safety engineer<br>• Unstructured/informal interviews with engineers during coffee/lunch breaks<br>*Documents*<br>• Internal OGC documents outlining LWI work practices<br>• Presentations produced by LWI engineers that present technologies, intervention types and experiences<br>• Intranet-based sources providing general information about LWI activities and news<br>*Observation*<br>• Passive observation of work practices in an open-plan office |

In total, 68 in-depth formal interviews, each lasting between one to three hours, were conducted. The first interviews were open-ended, with the goal of identifying the strategic IT visions and implementation activities related to collaborative systems.

Later interviews were focused on specific infrastructural components, work practices or individual engagements with technology. The technological complexity and purpose of the collaborative infrastructure were discussed with developers, administrators and managers of the infrastructure. Fourteen formal interviews were conducted with actors in this group, and technology use was investigated with actors from several organisational units. Twenty-three formal interviews were conducted with various engineers and senior researchers in the R&D department. Twenty-two interviews were conducted with personnel in OGP (excluding LWI), in which we interviewed drilling, well, production and process engineers. Nine formal interviews were conducted with personnel from the LWI department, and we also interviewed five out of eight well engineers charged with the primary responsibility of planning light well interventions. Additionally, we interviewed one subsea engineer, one well planning manager and one health and safety engineer.

Participatory observation and informal discussions were conducted in several contexts. I have been granted access to one of the OGC research centres from the beginning of the data collection period. In January 2008, I was granted an office, plus access to the building and the OGC IT network, and spent up to three days per week in the research centre. In March 2009, I was granted access to the OGP site, a building used by several hundred various engineers and other professionals involved in activities of a specific oil and gas field. The LWI department happened to be located in the same building. I made seven field trips to the OGP site, and spent 20 full workdays conducting interviews, observing meetings and having informal chats during coffee or lunch breaks. Seven out of 20 workdays were devoted to studying the LWI department. The significant amount of time spent on-site helped to form an understanding of how work is carried out in practice, as well as the nature of the problems and frustrations that were experienced.

The third major empirical source of data was the internal OGC documents. I performed an extensive study of the strategic documents that were related to the planning and implementation activities of the collaborative infrastructure. In addition, I analysed the technical descriptions, formal presentations and training materials of various infrastructural components. A number of presentations, governing documents and formal process descriptions, which were related to R&D, OGP, and LWI activities, were also studied in detail. Finally, the OGC's intranet portal provided extensive contextual information on the diverse OGC activities.

## 4.3 Few insights on the process of conducting a multi-sited case study in a large organisation

While the previous section provides a realistic account in terms of the empirical data sources, the primary purpose of this section is to develop a more personal insight on the research process (Schultze, 2000; Van Maanen, 1988). The following issues are discussed: site selection, adjusting the research focus and access to management. Issues and concerns that are presented in this section are not necessarily essential to all longitudinal studies, but they did require specific attention during my study. In what follows, this section illustrates how a researcher interacts with research subjects (Klein & Myers, 1999) and outlines the need for a non-deterministic research design when conducting a longitudinal multi-sited case study.

### 4.3.1 Which sites to study?

During the early stages of the empirical work, my research focused on the implementation and use of a new collaborative system based on MS SharePoint technologies. From the beginning of this study, there was a plan to carry out a multi-sited study, thereby implying a need to study how technology (MS SharePoint) is used across different organisational contexts. The first site chosen was decided on rather pragmatically. The OGC has quite a large research centre in Trondheim and an internal OGC employee who facilitated my access was also based in Trondheim. Because of this, it was very easy to start conducting research at the R&D site. After some time, I developed an understanding of collaborative tools and some of the challenges that users face. In particular, I was attracted to the metadata standard, which was a new element within the collaborative infrastructure (see Jarulaitis, 2010). Based on my conversations with various users, I identified a number of problems, yet I thought that the metadata had a great potential for improvement and I wanted to discuss these issues with the technology managers. One of the employees working in R&D helped me to identify the people responsible for the development and maintenance of the metadata. These people are called Record Information Managers and I was happy that they agreed to meet with me in May 2008. I made a presentation and presented it to two RIMs during a web meeting. I was drawing on classification literature (see for instance Bowker and Star 1999) and emphasised the challenges and continuous imperfection of the classification standards. My main message was that a large majority of users are not satisfied with the metadata since it does not represent their local knowledge. Not surprisingly, my statement generated a lively discussion. I was warned that my findings were related to R&D contexts, and should thus not be generalised. The message was clear: “Researchers are special and are doing things in their own ways”. RIMs strongly suggested obtaining more empirical data from operational environments (i.e. various engineering disciplines involved in oil and gas production), as they have a rather different experience with the metadata.

According to Yin (2002), some case(s) and units of analysis should be planned before going into the field. On the other hand, more explorative and sometimes opportunistic ways of selecting cases were also reported (see for instance Pollock and Williams [2009]). Either way, the sites that a researcher is studying has implications for the findings, making it a central concern in a multi-sited study. Taking into account more explorative forms of research, a number of researchers used a so-called “snowballing” methodology for finding respondents for the interviews. Such a methodology acknowledges that a researcher has limited knowledge of a particular organisation and needs help from “internals”. IS studies most often follow a particular system and analyse how it is implemented and used across various contexts. Pollock and Williams (2009) recently developed a “biography” perspective, which captures the evolution of a particular class of artefacts across different time and space settings. When it comes to the selection of a case or multiple cases, Yin (2002, p.47) suggests following the logic of replication so that a case “either (a) predicts similar results (a linear replication) or (b) predicts contrasting results, but for predictable reasons (a theoretical replication)”. Flyvbjerg (2006, p.229) emphasises the importance of contrast as “atypical or extreme cases often reveal more information because they activate more actors and more basic mechanisms in the situation studied”. Such a perspective is also in accordance with the logic of opposition (Robey & Boudreau, 1999).

With the feedback from RIMs, I realised that my findings from the R&D contexts tell the story of resistance and the RIMs suggested I take a look at a possible success story. The advice I got from the RIMs was very valuable indeed, as it challenged my generalisations, made me reflect on my findings and more actively think about a new site. Nonetheless, the RIM’s could not direct me to any of the sites, so I was left on my own, with at least five potential onshore geographical sites where several hundred engineers were involved in various oil and gas production activities. My supervisor and a few OGC employees advised me to select the oldest operational site (OGP site), which had been working with oil and gas production since early the 1970s. Unfortunately, the OGP site was in a different town, and more importantly because of its size, it was not clear where to start. So consequently, I was once again dependent on internal R&D employees for helping me find a contact person in the OGP site. In

October 2008, I made my first trip to the OGP site to interview Harald,[9] a manger responsible for the operation and maintenance activities of a particular platform. During the interview, Harald gave me a brief presentation on his work practices. He was quite interested in my study and willing to help me to navigate in this new setting. When I asked Harald when we could have another meeting, he replied: “check my calendar and send me an invitation”. When I had a look at Harald’s calendar (see Figure 1), I realised the challenges that awaited.

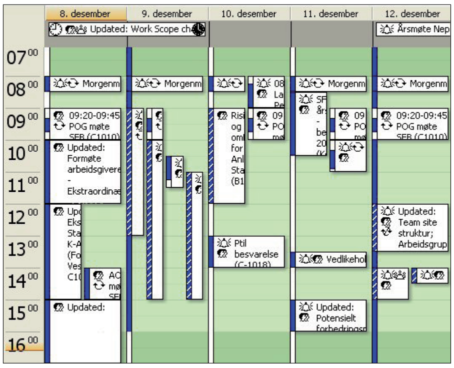


Figure 1 - Harald’s calendar for one week (in December 2008), available from MS Outlook

### 4.3.2 Adjusting the research focus

*I meet with Karoline by the security gate. We shake hands and exchange names. It is my second visit to this place, and I immediately notice that Karoline is a very active and joyful person who is willing to help me today. From our e-mails, I know that Karoline will introduce me to several people that Harald recommended. Harald has a “hectic” schedule, so it took quite some time to arrange this trip. A day before I arrived, I received an e-mail from Harald saying that he had to go offshore, but he did not want me to postpone my trip once again, so he asked Karoline to show me around. As we climb to the second floor, Karoline says that a “morning meeting” will be starting in a few minutes and asks whether I would like to join. I did not know about it beforehand, but I instantly expressed my interest in observing the meeting.*

*About 15 persons were having a chat at the end of the corridor, and we started to approach them. The place we were at was actually a coffee drinking area currently serving as a meeting room, with a high desk and some chairs around it, yet nobody is sitting. I instantly become attracted to the smell of coffee since it is 8:30 on a Monday morning, and I had to get up at 4:30 in order to catch an early flight.*

[9] All names are anonymised.

*There is a wireless mouse, keyboard and a remote control on the table, and the walls are decorated with technical drawings of the platforms. As I will later discover, these people are engineers who responsible for the maintenance of diverse technical equipment on the platform. To my surprise, Karoline takes the main chair, opens her notebook and logs in, as she is the meeting coordinator. Karoline explains that a PhD student wants to acquire some insight on their work practices and asks me to present myself. After my short presentation, Karoline starts reading from her notebook in relation to the status of several platforms. As she later explained that day, these notes were taken during another meeting with platform managers held at 8:00 o'clock. Afterwards, we all look at a white board. I am fascinated how they switch multiple applications and discuss numerous issues related to oil and gas production rates, problems with technical equipment, economic loss and other issues. The system that I am studying (MS SharePoint) was once on the screen… As they initiate multiple discussions, I realise that I am able to capture only a fraction of it. I have many, actually too many questions, about all this, though I just stand and listen with a visitors badge attached to my sweater and a coffee cup in my hand. (Personal field notes, February 9 2009)*

A rather straightforward strategy for studying a new site is to follow the system and analyse how the system is implemented/used within the new site. Such an approach captures both the similarities and differences across sites, which results in a rich description of how a particular system "works" across contexts (Jarulaitis, 2010). A more demanding methodological strategy would require encountering a new site on its own rather than solely obtaining additional perspectives on a specific system. From such a perspective, the focus of the study is broadened and the new site is foregrounded. The notes above were written in the airport on the way home after an eye-opening field trip and are the first reflection of such an encounter. The meeting presented in the notes could be dismissed as not being relevant to my study since the system I am studying (MS SharePoint) was only used to a small extent. Additionally, the various issues discussed in the meeting were very specific, meaning that I may have just been wasting my time.

During my first encounters with the new site I started to reflect on my own research focus. I was interested in MS SharePoint and metadata from an R&D site, so it was quite natural to follow the same system, yet such a focus seemed to be rather excluding. When I asked my respondents to portray their typical working day they would mention MS SharePoint, but it was only one system among many others. For instance, during a two-hour interview a well engineer sketched some of the systems he was using on a sheet of paper (see Figure 2). MS SharePoint was part of our discussion (the box labelled TEAMSITE in the left corner of Figure 2), yet my respondent continued and both the list and interactions between the systems were growing.

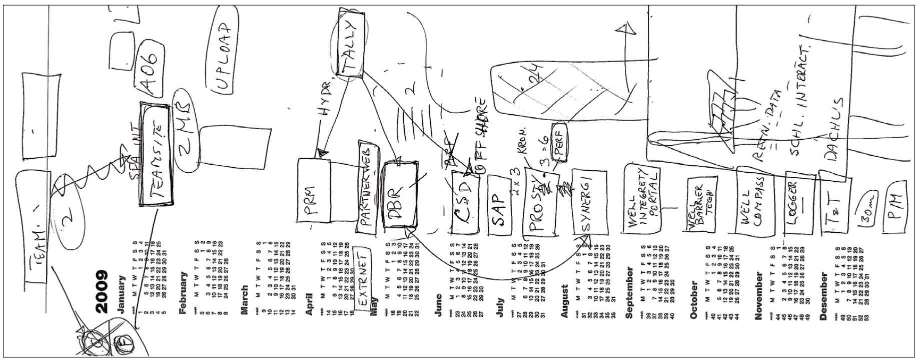

Figure 2 - Multiple systems used by well engineers

The need to broaden my own research focus was supported by multiple findings in the new site. Perhaps the most vivid was when another well engineer asked me whether I was interested in MS SharePoint or collaborative systems in general. I expressed my interest in various collaborative systems, yet to my surprise the respondent started to present systems that I had previously considered to be “specialized” for oil and gas production. According to my respondent, collaborative systems were also those that contain well completion information, daily drilling activities and other well-related information. This perspective was quite interesting, although it made me wonder whether it was a “mistaken” interpretation of a collaborative system. Science study texts provided a great inspiration for broadening my research focus. According to Mol (2003), the differences are not only epistemological, but ontological as well. In other words, Mol (ibid.) argues that the issue at stake is not one object with multiple interpretations, but rather co-existing multiple objects. This approach relates to information infrastructure studies, which emphasise embedded and relational aspects of socio-technical environments (Star, 1999). As a result, collaborative infrastructure is not a fixed (single) object; it is actually composed of various components that are different across sites. Such a perspective challenges the boundaries created by systems (e.g. the boundary between a collaborative and a specialised system), which aims to show how social and technical elements are configured (Jarulaitis & Monteiro 2010).

### 4.3.3 Gaining and maintaining access

For any in-depth study, gaining access to the organisation is of crucial importance, though as many scholars have reported, acquiring access is not always a straightforward process. It is a time-consuming effort, which does not necessarily end up with permission to study a particular site. In addition, a researcher might be asked to modify his/her research focus. Having outlined those difficulties, access is quite often described in a rather binary manner, either having access to organisation or not. In that sense, there is little elaboration as far as what access is needed and when. As Walsham (2006) has recently outlined, gaining access is not an instance, but instead is a continuous process which needs to be maintained throughout the study. The following section illustrates how access was maintained during this study.

My collaboration with the OGC was enabled due to my supervisor's connection with the company. Since the late 1990s, he has been involved in several research projects related to the implementation of large-scale systems in the OGC. The idea to study work practices in several contexts emerged in collaboration with several researchers from my faculty and a few internal OGC researchers. For that reason, my research was connected to a larger research project right from the start.

Initially, I was granted access to one of the OGC's research centres located in Trondheim. I received a badge with my photo, which I still use to enter the building. Up until recently, the badge had a different colour from the one that OGC employees have, so it was easy to identify me as an "external" person. In addition, I only had access to a few OGC IT systems. In the beginning, my access rights were limited, yet I had an e-mail account and access to the OGC's intranet portal. More importantly, I had an opportunity to use one of the desks in the research centre, so for quite some time I was able to navigate rather freely in the research centre, conduct semi-structured interviews or have informal chats around a coffee machine. The possibility of sitting by one of the desks also proved important, as I could passively observe how people were working and what frustrations they had on a daily basis.

Therefore, I had access to the most important components, yet I started to encounter the complexities of "access" later in the study. While I was studying the collaborative system (MS SharePoint), I did not have access to it. During interviews, my respondents would show how they navigated within the system, yet I did not have the possibility of going back and studying a particular team site in more detail. My understanding of technology use relied on user manuals and user's perceptions. User manuals, however, only introduce some basic functions of technology, whereas more advanced functionality must be learned by users on their own. Hence, if a user resists the system, it is difficult to tell whether a particular functionality is missing or a user only has limited knowledge about the system. In order to attain access to MS SharePoint, I had to contact team site administrators. As I received access to several team sites, my role changed from being a passive listener to an active one, who was able to discuss the problems and challenges rather than take note of a first user's formulation. In addition, I could passively observe the system's use and ask users about certain aspects later (see Jarulaitis 2010).

While I had extensive access to the R&D site, entering a new site implied an extensive negotiation and explanation of what access I needed and for which purposes. I did not have access to the OGP building; during my first field trips, a permanent employee had to let me in and eventually lead me out of the building. While it was a quite simple procedure, it meant that I could only visit the OGP site for planned interviews, and had limited possibility to navigate the site on my own. Gaining access to the OGP site was tightly related to trust and employee recognition of the importance of my research. From that standpoint, not only did I need access to the building, but more importantly I had to find one or a few key persons who were interested in my research and were willing to help me to navigate in this new setting. Karoline and Harald were key door openers to the OGP site. During my fourth trip to the operational site, I negotiated the possibility for my intense study. I acquired access to the building and was allowed to use a desk during my stays. As outlined above I had to negotiate access to various team sites, observe meetings and study LWI work practices.

## 4.4 Data analysis

Data analysis is a laborious process, during which a researcher tries to make sense of the collected empirical material and relate it to existing theories. Longitudinal qualitative research is associated with large amounts of empirical data, so it is a key concern to establish "working" analysis practices. A number of different analysis techniques were proposed, ranging from rigid/systematic approaches such as grounded theory (J. Hughes & Jones, 2004; Urquhart, 2001) to loose guidelines (Klein & Myers, 1999; Walsham, 1995, 2006). The analysis process of the reported research relied on the latter approach.

A set of steps developed by Miles and Huberman (1994) reflect the main analysis activities undertaken during my research project:

- giving codes to the initial set of materials obtained from observation, interviews and documents analysis;
- adding comments and reflections;
- going through the materials, trying to identify similar patterns, themes, relationships, sequences and differences;
- taking these patterns and themes out to the field to help focus on the next wave of data collection;
- gradually elaborating a small set of generalisations to cover the consistencies you discern in the data;
- linking these generalisations to a formal body of knowledge in the form of constructs or theories.

While the proposed steps are outlined sequentially, the analysis in longitudinal research is rather continuous and iterative with an ever-changing intensity. As suggested by Klein and Myers (1999) the analysis process can be understood as a hermeneutic circle, which refers to relating the whole to the part and the part to the whole. The 'part' is not a fixed unit, but rather flexible one allowing changing the unit of analysis for a given purpose. When writing a paper for instance, a 'part' can be an individual engagement with technology and the 'whole' an emerging explanation of cross-contextual enactment (see Jarulaitis & Monteiro 2009). On the other hand, when writing the thesis a paper becomes as a 'part' in a larger context. The constituting parts of hermeneutic circle are discussed in more detail bellow.

The analysis process of the reported research started after the first discussions with the OGC actors. As mentioned above, several researchers from my faculty were involved in the same project, resulting in discussions from the start on various issues that attracted our attention. More intensive and personal data analysis started when I began to navigate through the OGC on my own. During observations and interviews, I would make field notes, or when appropriate, use a voice recorder. I aimed to transcribe my first interviews quite carefully so that important details would not be missed. When transcribing, I would separate my notes from what was actually said in the interview (see Table 3), so that I could later read the original text and make new interpretations and relations to theory. In addition, I would also have a timestamp in order to go back to the original recording and listen to it again.

**Table 3 - An example of interview transcriptions and coding**

| TIME | INTERVIEW | COMMENTS/NOTES |
|---|---|---|
| 10:00 | EK: "from the beginning, it was very clearly communicated that we are not allowed to use workspaces to replicate folder structure. That was the intention. Most people here have used computers [and folders] for the last 15 years…so they actually continue to make folders with workspaces despite the fact that they are told not to do that…<br><br>GASPARAS: how often are such "folders" produced?<br><br>EK: "all our team sites have a pile of workspaces" [the user navigates to one of the team sites and shows a list of some 30 workspaces] | OPEN CODES:<br>• workspace<br>• folder structure<br><br>THEORETICAL NOTES:<br>• workaround<br>• resistance<br>• installed base |

Being a non-native Norwegian speaker, I conducted my first conversations and interviews in English, but by the end of 2009 I almost entirely relied on my broken Norwegian and some English words. Given that Norwegian is a foreign language for me, I inevitably missed some key aspects. As a consequence, in the beginning of my data collection I heavily relied on my voice recorder and extensive transcription efforts. In addition, given that some formal and informal interviews or observations were carried out together with other researchers from the faculty, I would make clarifications during the discussions in order to make sure that no important details were missed.

As the intensity of my research increased and I became more comfortable with the Norwegian language, my data analysis changed slightly as well. During a two-day field trip to the OGP site, I would conduct up to eight planned interviews and have numerous chats. Producing detailed transcriptions was therefore postponed, so instead I would make a "partial" transcription by identifying a set of themes with corresponding time stamps. If I found that a certain part of the interview was "interesting", I would spend more effort on transcribing it. As I collected more data, my role from being a listener changed to a more active one, in which I aimed to discuss and analyse various issues with my respondents. In particular, my goal was to identify multiple perspectives (Klein & Myers, 1999) and triangulate different data sources. During the interviews I would refer to various data sources such as previous interviews, documents or my impressions from observations, and ask my respondents to elaborate on their perspective in relation to other ones. Thus, interviews became a place for discussion and analysis. My empirical data was primarily focusing on "users", yet on several occasions I would present my findings to "managers". For instance, many users complained that MS SharePoint was difficult to use when manipulating many documents in parallel. When I presented these issues to mangers, they showed that, even though it exists and is not identified by many users, functionality can solve the problem. Accordingly, I would communicate the possibilities of technology during the later interviews or meet with the person who complained. Such interaction with subjects has not only the purpose of obtaining multiple perspectives but rather activates researchers suspicion and increase the validity of interpretations (Klein and Myers 1999).

In parallel to data collection activities, paper writing is an integral part of doctoral work. During the period of article writing, the intensity of data analysis becomes highly increased. In particular, the role of theory took on a central role. As Walsham (1995) suggests, theory can be used as: i) an initial guide to design and data collection; ii) as part of an iterative process of data collection and analysis, and iii) as a final product of the research. My data collection activities were especially influenced by research on information infrastructures (see Section 2.5.3) and the social studies of IS (see Section 2.2). When one is writing a paper, it is required to relate, apply and extend existing theory. This process implies balancing both inductive and deductive reasoning. While my early papers were more deductive (Hjelle & Jarulaitis, 2008), my later papers were intended to show how statements evolve from data. When writing a paper, the analysis work focused on identifying similarities, differences and relationships between different interviews, observations and documentary evidence. In addition, it also required establishing connections across different data sources. Moreover, all the papers published during this research project should be considered as a collective product. The quality and validity of the papers was enhanced by extensive discussions with internal OGC employees and colleagues at the faculty. Furthermore, several hermeneutic cycles were required in order to produce the final version of a paper.

Writing a new paper required the performance of the above outlined analysis process from the beginning as “each theoretical stance and each research question open up a unique reading of the transcripts” (Boland, 2005, p.231). Writing a new paper implied the reading of transcriptions, listening to recording, producing new codes, identifying similarities and differences, as well as making new relations.

During the later stages of my fieldwork, the data collection and analysis become more selective. In particular, this reflects my engagement with the LWI department. I was accidentally introduced to a well engineer from the LWI department in March 2009, and during a three-hour interview, I recognized LWI work practices were very different from what I had previously seen. While my previous respondents were working with the same wells over time, the LWI had the responsibility of conducting well interventions across numerous oil and gas fields. Additionally, my interest in studying LWI work practices more closely was also theoretically motivated. Having previously reported on situated work practices, we identified LWI as an extreme case (Flyvbjerg, 2006) which has the potential to provide new insights and challenge existing theory. Employing the principle of dialogical reasoning (Klein & Myers, 1999, p.76) the LWI case allowed reflecting on the constructed interpretations and theoretical perspectives employed in the beginning of this research project. While previously we emphasised the importance of cross-contextual differences (Jarulaitis 2010) now it required reflecting on similarities and why differences do not prohibit collaboration across contexts. Drawing on the social studies of IS (see Section 2.2 and 2.3) one could argue that working across contexts would impose major challenges, yet the LWI case showed that such work is indeed difficult, yet is practiced on a every-day basis. As result, the data collection in LWI context was not entirely explorative, but instead aimed to identify challenges and means for working across multiple oil and gas fields.

Overall, the analysis work was continuous and iterative, following multiple hermeneutics cycles. Activities such as coding, identifying patterns, triangulation and relating empirical data to theory were central to the analytical process. In addition, discussions with various actors were also integral to the analysis process and took place in three different arenas, namely the OGC, my faculty and academic conferences or workshops. When it comes to generalisations (Walsham, 1995), we aimed to develop conceptualisations related to cross-contextual use (Jarulaitis & Monteiro, 2009) and cross-contextual work (Jarulaitis & Hepsø, 2010), propose specific implications for both practice and theory (see Section 6), and contribute with rich empirical insights on integrated technology implementation and use.

# 5 Results

This thesis includes the following five papers:

1. Hjelle, T., & Jarulaitis, G. (2008). *Changing Large-Scale Collaborative Spaces: Strategies and Challenges*. Paper presented at the 41st Hawaii International Conference on System Sciences, Hawaii.
2. Jarulaitis, G., & Monteiro, E. (2009). *Cross-contextual use of integrated information systems*. Paper presented at the 17th European Conference on Information Systems, Verona, Italy.
3. Jarulaitis, G. (2010). *The Uneven Diffusion of Collaborative Technology in a Large Organisation*. Paper presented at the IFIP WG 8.2 + 8.6 Joint International Working Conference, Perth, Australia.
4. Jarulaitis, G., & Monteiro, E. (2010). *Unity in Multiplicity: Towards Working Enterprise Systems*. Paper presented at the 18th European Conference on Information Systems Pretoria, South Africa.
5. Jarulaitis, G., & Hepsø, V. (2010). Cross-contextual work practice: Investigating strategies for navigating across islands of knowledge. Submitted to the *Information and Organization* journal.

The papers that are included in this thesis have been written in different stages of the PhD research project, and are listed in the sequence in which they were published. The sequence and different aspects covered in the papers reflect changes in my analytical thinking and changes in my engagement in the field. All papers, even if I was a single author, should be seen as a collective product, as I have benefited highly from discussions with my supervisors, colleagues at my faculty and OGC employees.

The papers investigate two research questions outlined in the introductory section:

RQ 1: How do users enact the same integrated system in different contexts, and what are the effects of local enactments?

RQ 2: What are the dynamics of an integrated system implementation, and how does it influence organisation-wide integration efforts?

Paper 1 was written in the beginning of the data collection process and to a large degree is an analytical one that identifies challenges when establishing large-scale collaborative infrastructures. Paper 1 relates RQ2. Papers 2 and 3 are closely related, as they illustrate different technology enactments across contexts (particularly Paper 3) and the consequences of local enactment over the dimensions of both time and space (particularly Paper 2). Both papers are addressing issues related to RQ1, yet paper 3 also contributes to RQ2. Papers 4 and 5 analyse collaborative work practices around a key object in oil and gas production - a well and aim to conceptualise integration in large-scale contexts. These papers also mark both theoretical and empirical changes in my PhD research project, as I switched from analysing a system/systems to understanding core work practices in oil and gas production. Both papers contribute to RQ2, yet also present various users' strategies and relate to RQ1.

**Table 4 - A brief outline and contribution of each paper**

| TITLE OF THE PAPER | THEORETICAL GROUNDING | RESEARCH QUESTIONS | CONTRIBUTIONS |
|---|---|---|---|
| Paper 1 - Changing Large-Scale Collaborative Spaces: Strategies and Challenges | • Common Information Spaces<br>• Integration | RQ 1: How do users enact the same integrated system in different contexts, and what are the effects of local enactments?<br><br>RQ 2: What are the dynamics of an integrated system implementation, and how does it influence organisation-wide integration efforts? | The paper relates the notion of CIS to integration literature to emphasise non-technical aspects of integration. We suggest large-scale CIS is composed of smaller overlapping common information spaces containing the heterogeneous collection of socio-technical arrangements that need to be continually (re)negotiated by the actors involved. These findings are in contradiction with intentions to establish tight integration. |
| Paper 2 - Cross-contextual use of integrated information systems | • Enactment, Workaround<br>• Spanning effects | | This paper contributes by conceptualising enactments of integrated technology. As opposed to largely local independent contexts of enacted technology, the use of integrated systems implies the interdependent enactment across contexts now linked as a result of integration. |
| Paper 3 - The Uneven Diffusion of Collaborative Technology in a Large Organisation | • Configurational technology<br>• Process perspective on diffusion<br>• Modes of ordering | | Our findings support the process perspective of diffusion. Drawing on the concept of configurability, we suggest that it is not only technical aspects that have to be configured, but also modes of ordering as well. On practical concerns, this paper illustrates the difficulty of achieving uniform patterns of use across contexts. |
| Paper 4 - Unity in Multiplicity: Towards Working Enterprise Systems | • Enterprise systems<br>• The concept of multiplicity | | We conceptualise enterprise systems as being multiple. This allows us to resolve seemingly paradoxical (homogeneous/heterogeneous) characteristics of enterprise systems. We argue that the need for unity could be overstated, and empirically illustrate different ways in which "temporal" unity is achieved. |
| Paper 5 - Cross-contextual work practice | • Situated<br>• Trans-situated<br>• Syntactic, semantic, and pragmatic levels | | Drawing on science studies the paper challenges 'localist' perspectives that work practices invariably vary across contexts and illustrates the work needed to transfer, translate and transform knowledge across boundaries. |

## 5.1 Paper 1 - Changing large-scale collaborative spaces: Strategies and challenges

The theoretical basis of this paper primarily comes from CSCW literature and specifically draws on the notion of Common Information Space (CIS). The relevance of the CIS concept is that it allows the addressing of challenges in establishing a large-scale collaborative space. Instead of ascribing determinist power to collaborative technology, Schmidt and Bannon (1992) argue that CIS can be achieved only through active construction by the participants involved. More recent contributions on CIS emphasised the idea of commonality and the need to study large-scale settings (Randall, 2000; Rolland, et al., 2006).

Drawing on these insights, we identify a number of challenges when establishing a large-scale CIS in an OGC. In the analysis section we address the nature and composition of CIS as well as flexibility, heterogeneity and the management of CIS. Our empirical material suggests that large-scale CIS is composed of smaller overlapping common information spaces which contain a heterogeneous collection of socio-technical arrangements that need to be continually (re)negotiated by the actors involved.

Our conceptualisation of large-scale CIS challenges the assumption that collaborative work should be supported with centralised and tightly integrated information systems.

## 5.2 Paper 2 - Cross-contextual use of integrated information systems

The idea for this paper emerged gradually while reading studies on how information systems are implemented and used in organisations. The theoretical basis of the paper builds on the empirically grounded notions of workaround (Gasser, 1986) and enactment (Orlikowski, 2000). While these notions were applied across a wide range of different empirical settings, the majority of the studies were limited to the identification of workarounds as opposed to explanations of the effects produced by workarounds outside their immediate context of use. We attempt to fill this gap by drawing on conceptualisations of technology as reading and writing artefacts (Berg, 1999) and literature on integrated systems which emphasise spanning effects (Ellingsen & Monteiro, 2006; Hanseth, et al., 2001).

The analysis is conducted in two stages. First, in line with previous accounts, we demonstrate two widely practiced workarounds in the OGC (the use of workspaces and the classification of documents). Workarounds are practiced due to entrenched practices, mismatches between technology and local contexts or alternative/easier ways to perform a specific task. More importantly, however, we go on to identify how these local workarounds – as a result of the tight integration within MSP – shape use patterns in other contexts of use. The most vivid example of this cross-contextual effect is the availability of sensitive information. The incorrect classification of documents, due to a tight integration with the corporate search engine, made it possible for confidential information to be made available to many more than it should be. Over time, the amount of incorrectly accessible confidential information significantly increased, which evoked the decision to suspend the corporate-wide search engine for five months, a period that was used to "clean up" incorrect classifications and prohibit similar enactments in the future.

We draw two sets of implications from our study of an MS SharePoint based information infrastructure in an OGC: one analytical and one practical. Analytically, we are addressing the nature of non-local effects which are embedded in the appropriation of integrated systems. As opposed to largely local independent contexts of enacted technology, the use of integrated systems implies an interdependent enactment across contexts now linked as a result of integration.

On a practical note, integrated technology is more often evaluated from a perspective of what positive effects it can bring, while underestimating how local (though seemingly small and unimportant at first) activities can produce great (and unintended) effects some time later across contexts. This implies that a certain level of uniform use and users' awareness of cross-contextual effects is a prerequisite for working with enterprise systems. Additionally, we argue that workarounds are not anomalies which have to be eliminated (Azad & King, 2008), but constitutive elements of working technologies which should be evaluated as "costs" for establishing working technology.

## 5.3 Paper 3 - The uneven diffusion of collaborative technology in a large organisation

The paper draws on CSCW literature, which suggests that groupware technologies have to be flexible in order to accommodate unanticipated and innovative patterns of use (Andriessen, Hettinga, & Wulf, 2003). Rather than seeing large-scale technologies as self-contained and rigid artefacts, we conceptualise MSP as being configuration technology (Fleck, 1994), consisting of multiple modules which can be added, removed or modified. Finally, we draw on the notion of "modes of ordering" (Law, 1994) to demonstrate how the trajectory of large-scale technology is influenced by many ordering activities which run in parallel and interact.

In order to highlight the configurational capabilities of technology, we do not discuss MSP as a whole, but instead focus on the metadata standard, an in-house developed infrastructural component in the collaborative infrastructure developed to improve information retrieval and retention. Our analysis identifies differences in R&D and OGP. The metadata development in R&D was lagging, thus resulting in a poor quality of classification scheme that invoked workarounds in terms of the replacement of values. The development and use of metadata was more successful in OGP, which is explained by the active development of metadata values and more structured work practices in OGP.

Our findings support the process perspective of diffusion (Henriksen & Kautz, 2006). While the concept of configurability was originally associated with the modification of technical parameters, recent contributions argued for the importance of configuring "political" aspects (Sahay, Monteiro, & Aanestad, 2009). Similarly, we suggest that it is not only technical aspects that have to be configured, but modes of ordering as well.

When it comes to practical implications, we argue that it is important to acknowledge that large-scale technologies are configurable, i.e. consisting of multiple and changing components. Components diffuse at different rates, implying that consistency (in terms of common patterns of development and use) are difficult to achieve.

## 5.4 Paper 4 - Unity in multiplicity: Towards working enterprise systems

The conceptual lens of this paper emerged in the later stages of the empirical work when trying to analyse and understand the challenges and benefits of enterprise systems. We draw on the literature of enterprise systems as we consider MSP to be in this class of systems. Enterprise systems were widely criticised since they impose a certain logic to a workplace and cannot accommodate cross-cultural (Soh, et al., 2000) differences or differences across communities in general (Wagner & Newell, 2004). But, as practice-based research seems to suggest, if the enactment of enterprise systems varies with situations and users, have all aspirations of unity then evaporated? Drawing on actor-network theory-based insights, we discuss conceptualisations of material artefacts embedding degrees of multiplicity (Mol, 2003).

Given the seemingly chaotic (i.e. full of inconsistencies) version of reality produced by practice research, the main purpose of the analysis section is to investigate how unity is achieved in practice. We propose that the case for unity, i.e. the need for tight coordination, integration and standardisation, may well have been overstated. Our case strongly suggests that the lack of a unit is not necessarily a big problem for the users. On the contrary, they display varied socio-technical strategies on demand. Through strategies of navigation, indexing and patching up a trajectory, relevant aspects of the well are united for the given purpose at hand. The various communities of users do not make an investment necessary to maintain the degree of coherence and unity laid out for instance within a boundary object/infrastructure perspective, but postpone it until it becomes necessary to patch it up.

From a practical point of view our findings suggest that enterprise systems are not an issue for/against unity, but rather at what cost should unity be achieved. Where effective strategies for patching up unity are in place and/or the frequency of this taking place is relatively low, it makes better (cost-effective) sense to not invest resources to establish higher degrees of unity on a more permanent basis. On the other hand, if unity needs to be achieved quite frequently, it is wise to establish more stable objects.

## 5.5 Paper 5 – Cross-contextual work practice: Investigating strategies for navigating across islands of knowledge

This paper relates to recent discussions within the IS field on the non-local aspects of work (Pollock, et al., 2009; Vaast & Walsham, 2009). As discussed in section 2.2 the social studies of IS have been predominantly interested in analysing and conceptualising the local aspects of work practices. Core contributions illustrate that actors enact different work practices, which further change over the time (Orlikowski, 1996, 2000). This perspective was confirmed in different organisational settings and with different technologies in place (Boudreau & Robey, 2005; Robey & Sahay, 1996).

'Localist' perspectives are not particular to IS field but can be identified across various fields. Science scholars have started to discuss the limits of 'localist' perspectives and inquire how science/knowledge/practice does 'travel' across contexts. Turnbull's (2000) suggested there are multiple socio-technical strategies "for treating instances of knowledge/practice as similar or equivalent and for making connections, that is in enabling local knowledge/practice to move and be assembled" (ibid., p.41). Organisation scholar Carlile (2000, 2002) have also aimed to explain how work across contexts is facilitated. Carlile's work is particularly relevant as it sorts-out differences along syntactic, semantic and pragmatic levels. Such classification increases precision when talking about differences and indicates the different mechanisms required to resolve particular differences.

Drawing on the above outlined framework, the primary purpose of analysis is to investigate and explain how similar work is performed across different contexts. We investigate how a group of engineers are planning well maintenance work across numerous oil and gas fields. In line with social studies of IS we illustrate how well engineers encounter various differences as they plan well interventions. More importantly however, the analysis illustrates that through strategies of drawing on templates, filling gaps, sorting uncertainties, and drawing on external expertise well engineers are capable to resolve differences and get close enough to local knowledge in order to plan and perform well interventions in a cost-effective and safe manner.

The primary purpose of the discussion section is to address the existing overemphasis that work practice is bound to local contingencies. Through education, training and daily practice well engineers enact a common ground with other professionals working with subsurface equipment. In that sense, well maintenance across oil and gas fields can be considered as work within the same community. Such treatment of 'local' might require revising existing perspectives, which draw clear-cut boundaries relating to a geographical place or formal division of labour. Additionally, well engineers draw on a common syntax (such as plans, process descriptions and other formal documentation), which is a crucial resource for planning well interventions. In short, well engineers draw on a common syntax and shared understanding, which are not identical across contexts, yet similar enough to enable the engagement.

# 6 Implications

## 6.1 Contributions to theory

### 6.1.1 Characterising integration on demand

Integration has become a central notion when aiming to improve collaboration and coordination across geographical or organisational boundaries (see Section 2.6 for more details). In the corporate world, integration is usually associated with technical work that is needed to connect given systems or the process of moving information from multiple systems to a single data repository. In either case, the end result is an integrated information infrastructure which allows for easy information sharing across contexts. The main challenge according to this perspective is to select the appropriate technique, tools and methodologies. Integration techniques are diverse and vary from 'loose' approaches when applications and databases are independent of each other but are integrated for instance through portals or 'tight' approaches when applications are integrated in such a way that they are dependent on each other. Despite the different approaches, even the technical literature states that "pursuit of application integration is like chasing the tail of a growing beast" (Linthicum, 2004, p.4).

Ongoing challenges to achieve the envisioned "seamless" integration have led the SSIS scholars to develop an alternative socio-technical perspective on integration (Ellingsen & Monteiro, 2006). This research stream aims to account for the process and consequences of integration. Scholars have vividly illustrated how a technical vision of tight integration did not deliver the expected results (Hanseth, et al., 2006; Hepsø, et al., 2009). For example, studies on global information systems have argued for contextual differences, and produced a dichotomy between a standardised global system and diverse local contexts (Joshi, et al., 2007). Studies that employ the notion of boundary objects argue in favour of a longitudinal process for establishing a common meaning among communities. Similarly, but with more attention to technical detail, information infrastructure studies have argued for gateways and small/continuous changes (Hanseth, 2000).

We want to propose an alternative, yet complementary socio-technical perspective on integration, particularly with concern to disciplines that do not collaborate continuously, but which instead interact rarely on an ad hoc basis, with their interaction being difficult to foresee. In such situations, integration is temporal and has to be achieved on demand. A good illustration of such a form of integration is provided by Mol (2003) when studying the various medical disciplines working around "the same" disease, atherosclerosis. Mol (2003) illustrates how different disciplines work independently to a large extent, yet when needed they do interact. Oil and gas production also represents a good example of such an interaction. A well is drilled by drilling engineers, production engineers optimise oil and gas production, and well engineers perform well interventions. While this is a highly simplified illustration, it does reveal how different disciplines work around the "same" object, yet their interaction is highly demand driven and discontinuous. This thesis provides an in-depth example of how well engineers have to temporarily interact with various disciplines across numerous oil and gas fields in order to perform a well intervention. The question of where or what type of intervention will be performed is difficult to foresee. Additionally, what is even more difficult is to forecast with which disciplines (e.g. drilling, production or subsea engineers, platform coordinators) or external vendors the collaboration will take place. As the technical approach suggests, facilitating such collaboration across boundaries does indeed require various (integrated) information systems, though this process is not a mere exchange or transfer (upload/download) of information. In this case, integration is a socio-technical process of navigating across multiple sources of information, identifying differences, filling gaps, sorting uncertainties, and initiating quality assurance mechanisms (Jarulaitis & Hepsø, 2010; Jarulaitis & Monteiro, 2010). In that sense, such a perspective on integration also presupposes that the distribution of information across systems (i.e. fragmentation) or various work practices across contexts does not prohibit collaboration.

This brings us to the core of the technical approaches to integration, namely the elimination of differences. Common taxonomies, work process descriptions and integrated systems aim to standardise the process and outcome of work (i.e. to eliminate differences). However, as the practice lens suggests, individual enactments always lead to differences (Orlikowski, 2000). Both approaches have their strengths and weaknesses. While in theory there is the possibility for different enactments, in practice the variations are limited, and there is also a high chance for similarities (Leonardi & Barley, 2008) which emerge in a specific group or over a certain period of time. More importantly, the notion of difference is ambiguous and rarely becomes explicitly discussed in terms of what type of differences users enact and what consequences these differences have for cross-contextual work or information management in general. By contrast, the technical approaches are not explicit as far as to what extent standardisation should be pursued in order to facilitate collaboration across contexts.

Our study shows that standardisation efforts are indeed important, yet differences are inevitable due to the scale and changes over the time. We aim to go beyond a mere identification of differences and employ Carlile's framework (2000, 2002) to sort out differences along syntactic, semantic and pragmatic dimensions. We argue that this framework allows for more specificity concerning the differences and their significance than the current practice lens suggests (Orlikowski, 2000). During the aforementioned study of well interventions, we have identified that well engineers most often encounter syntactic and semantic differences which are effectively sorted out with socio-technical strategies. During this study, we did not witness or receive examples of sharp pragmatic differences which would lead to conflicts or prohibit collaboration.

These findings have implications for both practice theories and standardisation efforts. One the one hand, we argue that the differences are overstated in the social studies of IS, and find Carlile's (2000, 2002) framework particularly suitable for discussing the role of these differences. On the other hand, standardisation efforts also need to acknowledge a certain level of inconsistency. As a result, integration on demand takes a performative stance on the differences/similarities. If disciplines interact often, it makes sense to invest in establishing common taxonomies and standardised work practices. Nevertheless, rare and ad hoc collaborative modes can be supported with loosely integrated systems.

As outlined above, the proposed perspective on integration is complementary to existing ones, but we argue that it provides additional insights on the discontinuities, temporality and performative aspects of integration.

### 6.1.2 Accumulating cross-contextual enactments

The main studies on IS implementation and use are primarily concerned with identifying whether people use technology as designers intended it (Orlikowski, 1992a) or conceptualise ongoing and changing situated actions (Orlikowski, 2000). The focus on how people interact with technologies here and now, however, does not emphasise the role of different technologies and overlooks the effects of local enactment over time.

As information infrastructure scholars (see Section 2.4.3) have clearly established, there is a sharp difference between stand-alone and integrated systems. User workarounds or system errors are localised with stand-alone systems, yet in cases of integrated systems local actions are no longer local, but depend on action in other contexts. Notions of side effects, ripple effects or domino effects (Hanseth, et al., 2001; Hanseth, et al., 2006) aim at exactly explaining interdependencies both within and across large-scale integrated systems. For instance, Rolland and Monteiro (2007) illustrated how an upgrade with the newest service pack from Windows NT caused a breakdown of the global IS that supports the technical inspection of vessels. Ellingsen and Monteiro (2006) also demonstrated how a standardised module serving multiple laboratories of a hospital was tailored for a clinical-chemical laboratory, while at the same time becoming less suitable for a microbiology laboratory.

Studies on interdependencies yield important insights on understanding the dynamics of integrated IS enactment. In contrast to conceptualising enactment as a local affair, it is important to address constraints that propagate across networks. Similar to the way that Boudreau and Robey (2005, p.13) indicated that "an error occurring at one level of the system would have a ripple effect at other levels", so do users' workarounds have spanning effects. In contrast to the outlined above, though quite dramatic technical side effects which lead to system disruption, we want to emphasise smaller ones that do not have immediately visible effects, yet have the potential for significant unforeseen consequences.

Over the course of the reported research we have identified two workarounds, namely document classification and the use of work spaces that require a different explanation than just a temporal enactment of the here and now. Firstly, the mentioned workarounds shape use patterns across contexts. For example, an incorrect adjustment of users' rights at a certain workspace implies that particular information has become unavailable to thousands of users. As a result, some users are not aware that certain information exists or that they have to perform additional work to locate it. Secondly, while enactments are temporal and change over time, they do accumulate and have long-term consequences. An incorrect classification of sensitive information not only implies that it becomes available to more people, but if the workaround is repeatedly performed by many people, the availability of sensitive information progressively increases. This took place at the OGC, when at first users would rarely and unintentionally find sensitive information. Over a period of three years (from 2006 to 2008) the workarounds accumulated, and the retrieval of sensitive information became so frequent that management suspended the corporate-wide search engine for five months, which became a period used to reclassify business-critical documents and develop more strict information classification control procedures. These findings suggest that IS scholars should be more attentive to studying the trajectory of a workaround. As opposed to largely local, independent contexts of enacted technology, the use of integrated systems implies an interdependent enactment across contexts now linked as a result of the integration, as we have stated (Jarulaitis & Monteiro, 2009).

One of the reasons that IS scholars pay too little attention to understanding the trajectory of a workaround is a predominant interest in studying and explaining what happens here and now. Theoretical conceptualisations (for instance situated action or interpretive flexibility) imported from other fields seem to have constrained SSIS scholars to focus on contextual users' interaction with a system. More recent science studies (Berg & Timmermans, 2000; de Laet & Mol, 2000; Mol, 2003; Timmermans & Berg, 1997), on the other hand, provide a good analytical lens for investigating the trajectory of a workaround, however this work has been embraced by only few scholars (see for instance Ellingsen and Monteiro, 2006).

Drawing on these recent science studies, we argue that a better understanding can be developed when studying "objects" that have a long "life". In the oil and gas industry, such an object is a well. Multiple disciplines work around a given well over a period of several decades and the various workarounds become accumulated in layers on top of each other. If a well is performing without disruptions, workarounds are not necessarily visible. However, if a particular piece of equipment fails, well engineers have to historically reconstruct the well in order to plan an intervention. During this reconstruction process, well engineers are exposed to multiple workarounds that have accumulated over time (Jarulaitis & Hepsø, 2010) and because of this, workarounds have cross-contextual, though not necessarily visible and immediate effects.

### 6.1.3 Characterising working systems

The social studies of IS have rejected technological determinism by illustrating user resistance, divergent technology use patterns (Orlikowski, 2000; Robey & Sahay, 1996), and challenges to achieve controlled technology diffusion (Ciborra, et al., 2000; Hanseth, et al., 2001). For that reason, the pendulum swung from optimistic notions of success to challenges, drift and failure. Still, the produced dichotomy does not allow for an explanation for how technologies work in practice, as the motivation to bridge the existing dichotomy comes from science studies. de Laet and Mol (2000) analysed how a water pump delivers water in Zimbabwe and offer a wonderful explanation as to why "binarity" should be avoided:

> The Pump may work as a water provider and yet not bring health. It may work for extended families but fail as a connecting element in larger communities. It may provide health in the dry season but not in the rainy season. It may work for a while and then break down. (de Laet & Mol 2000, p. 252)

IS researchers quite often approach technology as a rather stable and finished object, and subsequently compare whether use patterns deviate from designers' intentions (Orlikowski, 1992a). The technology is considered as "failed" or inadequate if it contains misfits (Soh, et al., 2000) or is not suitable for new/unplanned situations. Instead of seeing technology as finished, Knorr Cetina (2001, p.182-183) offers an alternative perspective:

> Even when [technology] is officially declared "finished" and "complete", the respective experts are acutely aware of its faults, of how it "could" have been improved, of what it "should" have become and did not. The "finished", [technology], then, is itself always incomplete, is itself simply another partial object.

Considering technology as always being incomplete requires a re-examination of the role and importance of a user's improvisational acts. An incompleteness implies that users have to improvise in order to fix it when it fails or adjust it to unforeseen situations. Consequently, workarounds are a prerequisite for technology to function (Timmermans & Berg, 1997). From that viewpoint, workarounds are not illustrations of a "failed" technology, but rather of the cost (i.e. work) needed to establish a working technology. This perspective is also in accordance with innofusion studies, which argue that innovation is not a built-in attribute during design, but a collectively gained characteristic acquired during the diffusion process (Fleck, 1994).

The notion of workaround emphasises how technologies are working in local contexts, yet lacks an explanation of how large-scale integrated systems become working systems. Drawing on social studies of IS, one could assume that over time use patterns can become so divergent that achieving unity across contexts is hardly possible. One explanation is given by Quattrone and Hopper (2006), who suggest that large-scale integrated systems (such as ERPs) are "heterogeneous"; they are a singular artefact, but simultaneously enacted in many indefinite different ways. We hesitate to call this phenomenon a "paradox", and offer a slightly different explanation. Firstly, we draw on Mol (2003) and conceptualise an object (i.e. a system) as being multiple rather than singular. It has different functionalities, configurations and users' extensions across contexts. Secondly, while theoretically there is "always the possibility of a different structure being enacted" (Orlikowski, 2000, p.412), in practice its variations are limited (Jarulaitis, 2010). Finally, while users' enactments lead to diversity, users employ multiple strategies on how to sort out differences and incompatibilities and achieve temporal unity (Jarulaitis & Monteiro, 2010). In Mol's

(2003, p.55) words, this implies that "even if [an object] is multiple, it also hangs together". In that sense, the strength of multiplicities (Mol, 2003) as an analytical framework is not an illustration of the differences, but rather temporal instances when unity is achieved.

According to this conceptualisation, the reason why enterprise systems work is because they are surrounded by multiple "complementary systems" (i.e. different enactments) and multiple socio-technical strategies for achieving unity. Therefore, workarounds explain why technology works locally, whereas the notion of multiplicities explains why integrated technology works across contexts.

## 6.2 Methodological implications

Methodological choices made by SSIS scholars seem to have restricted empirical inquiry to local studies of adoption. In particular, ethnography-inspired studies have limited data collection activities to users' interaction with a system in a single site. Interpretive case studies, on the other hand, are more flexible. In theory, interpretive methodologies do actually encourage studying multiple contexts and how a given system is developed and used over the time (see for instance Walsham and Sahay, 1999). The fundamental principle of the hermeneutic circle and the principles of contextualisation, proposed by Klein and Myers (1999) could be understood as a requirement for a researcher to place studied phenomena in larger contexts. In practice, however, the majority of the social studies of IS are limited to one site and capture only rather 'dramatic' (implementation phase) moments of technology diffusion (see Sections 2.1–2.3 for more details). As a consequence, existing methodological guidelines should be supplemented with more specific advice on how to investigate integrated systems.

As thick anthropological descriptions inspired IS scholars to develop a local-global dichotomy, inspiration on how to resolve the dichotomy can be found in the anthropological texts as well. As Marcus (1995) suggests, cultural formation cannot be understood by traditional "single-site mise-en-scene" since it takes place in several different locales. To capture cultural formation, Marcus (1995) suggests conducting a multi-sited (mobile) ethnography, thereby capturing cultural formation across and within multiple sites of activity.

IS scholars have also reported several multi-sited studies that include interesting comparisons of work and technology across different contexts (Barley, 1986; Robey & Sahay, 1996). More recent studies have identified technological constraints that propagate across multiple sites (Boudreau & Robey, 2005) and started to explore geographically distributed and technology mediated work practices (Vaast & Walsham, 2009). Interestingly, these studies still embrace in-depth case studies and ethnographies, however, an important difference is that a number of studied sites and the length of overall study have increased. One could argue that ethnographies and case studies will still be the main research approaches, yet in order to explain ongoing transition to large-scale systems SSIS scholars will have to develop more complex analytical frameworks and in particular aim to relate, compare and join diverse insights from multiple studies. As Marcus (1995, pp.101-102) explains:

> It is a mistake to understand multi-sited ethnography, as it sometimes has been, as merely adding perspectives peripherally to the usual subaltern focus… Rather, this kind of ethnography maps a new object of study in which previous situating narratives like that of resistance and accommodation become qualified by expanding what is ethnographically "in the picture" of research both as it evolves in the field and as it is eventually written up.

A multi-sited study does not necessarily need to follow the logic of replication in order to merely identify similarities or differences across contexts. Each site can be seen as a part of a larger context, thus providing a richer understanding of multiple socio-technical arrangements at work. Such an example is provided by de Laet and Mol (2000) by illustrating how both technology and surrounding work practices change in order to produce a working system. Another relevant multi-sited approach is proposed by Pollock and Williams (2009). In order to understand the widespread diffusion of enterprise systems, Pollock and Williams (2009) suggest studying the biography of the artefact. This implies exploring the "parts", such as multiple actors (vendors, users, consultants, etc.), across multiple arenas and constructing an understanding of the "whole", i.e. a diffusion of enterprise systems. Their insights on unexplored arenas such as user forums or industry fairs provide a better understanding on how vendors construct a generic system in cooperation with users.

In our reported research, we first followed a system (MS SharePoint) that resulted in producing a more diverse picture on how a system is implemented and used across several contexts (Jarulaitis, 2010). Yet, early encounters with a new site (OGP) clearly suggested that focusing on the same system is a highly excluding approach. While MS SharePoint was a rather central system in the R&D site, it was only an element in a large infrastructure in the OGP site (see Section 4.3.2). As a result, the empirical and analytical focus was broadened from understanding enactments of MS SharePoint in exploring work practices in general. In particular, we aimed at understanding work practices which surround the central object in oil and gas production – a well. Constructing such an understanding is definitely more demanding, yet the end product is a better understanding of work performed by engineers on a day-to-day basis. It became very clear in the OGP setting that in order to explain how an integrated system becomes a working system, it is not fruitful to restrict the research focus to that particular system since one way to explain why it works is because it is surrounded by multiple "complementary systems" and multiple socio-technical strategies for achieving unity (Jarulaitis & Monteiro, 2010).

In conclusion, SSIS scholars have, to a large extent, relied on in-depth case studies and ethnographies, which have allowed the production of rich insights on how diverse technologies are implemented in various organisations. Such insights however, are usually limited to single site and focus primarily on users' enactments during the implementation phase. As Pollock and Williams (2009) vividly illustrated such focus is rather narrow and excludes the multiple actors involved and long-term dynamics of large-scale systems. Consequently, in order to capture multiple actors during various time scales, there is a need to broaden research scope and in particular aim for multi-site studies or as Marcus (19995) suggests 'mobile' ethnographies. Longitudinal interpretive case studies could be seen as a prominent research strategy as they can include historical analysis (Mason, McKenney, & Copeland, 1997), span multiple contexts and draw on diverse data sources (see for instance Walsham and Sahay, 1999). While, a longitudinal study does provide better insights, taken alone it cannot explain the widespread diffusion of large-scale systems. As a result, scholars will have to make a collective effort in order to conduct and synthesise diverse research projects that embrace multiple time and space perspectives, incorporate different theoretical conceptualisations and draw on diverse (qualitative and quantitative) data sources.

## 6.3 Implications for managing integrated information systems

### 6.3.1 Implications for record information managers

How to improve information classification, retrieval, archiving and disposal is becoming a key concern for large public and private organisations. As one example, health care institutions have to ensure safe storage and easy retrieval of patient's data over long periods of time. Similarly, large-scale organisations operating across multiple continents and listed on several stock exchanges have to comply with increasing requirements for transparency and openness. In particular, all companies publicly traded on US stock exchanges have to comply with SOX, which requires increased documentation, transparency and accountability. Ensuring long-term information retention and accountability requirements imply having development policies on how to manage information as well as the implementation of sophisticated information systems. In this context, document classification, metadata utilisation and access management are seen as important techniques in supporting information retrieval and long-term retention.

Drawing on the reported research so far, we identify several implications for developing and maintaining classification systems. Firstly, our empirical data demonstrates that ambitions to achieve better information retention and retrieval with top-down developed classifications should be reconsidered. It is not worth the effort of developing too generic of a classification since users will have to adjust (workaround) them anyway. As argued in Jarulaitis (2010), a top-down approach fits better for repetitive and extensively detailed tasks, though if a project is innovative and spans across multiple disciplines a rigid classification structure and predefined values are of little relevance. These findings are related to what Gartner explains as an imbalance between long-term and here and now information management:

> Information and enterprise architects tend to focus most of their efforts and tools on the long-term retention and archiving of this content for compliance and risk management reasons. They often overlook ad hoc content and collaborative processes. (Gartner, 2008, p.7)

In some instances, focusing predominantly on top-down classification to increase long-term retention can lead to the opposite result. As we have illustrated, users can replace predefined values or undermine the classification by storing documents in other systems such as file servers or personal computers. An alternative to top-down approaches requires user involvement. The concept of web 2.0 precisely denotes the shift from seeing users as passive readers to actively engaged users who shape the content and structure of information, with the widespread diffusion of wikis, blogs and social networking sites illustrating this change. Particularly relevant in this context is the notion of folksonomy, which was proposed in opposition to taxonomy (i.e. a controlled vocabulary) and refers to the tagging of documents by users (Boast, Bravo, & Srinivasan, 2007).

The OGC has also recently performed an evaluation of the metadata standard and outlined that "one size does not fit all" and user tagging possibilities should be considered. Nonetheless, there is an assumption that user tagging somehow implies a lack of control, yet as Boast et al. suggest (2007, p.399):

> Despite predictions by advocates of traditional meta-standards that [folksonomies] should lead to chaos and disorder, this breakdown has not

materialised. In fact, the folksonomies seem to generate great activity and usage.

The main challenge for organisations that aiming for better retrieval and long-term retention is not however choosing either taxonomy or folksonomy, but instead finding a way of how to combine these approaches. One way for finding such a balance would require indentifying objects/elements that are stable and less ambiguous. Additionally, user tags can be also utilised when developing more stable classification. In any case, user tagging should be considered as an approach rather than an ultimate solution because classification systems are not stable, but continually changing (Bowker & Star, 1999).

Overall, we see that the role of information managers is that of a changing role. While information managers previously had an exclusive role in developing classification systems, users can now perform an extensive amount of the work required to develop and maintain classification systems with the help of tagging technologies and bottom-up methodologies. This implies the redistribution of the workforce and a change in the information manager’s role. While information managers will perform a certain amount of “classification work”, they also have to find the means of how to facilitate user tagging activities.

A further challenge for information managers relates to access management. The widespread diffusion of enterprise systems and extensive efforts to establish integrated information infrastructure are aimed at increasing the availability of information anytime/anywhere, while at the same time some information should be accessible only by a certain community, and as the availability of information increases, privacy and data protection concerns are becoming more important as well. During our research, we observed an imbalance between these aspects, with issues of availability rather than confidentiality receiving more attention. Such an imbalance produced a significant side effect since regular users were able to retrieve confidential information. One way of explaining such a side effect is understanding the distinction between single-user and multiple-user systems. In theory, such a distinction was made a while ago (Grudin, 1989), yet during the study we observed that a number of users were not aware that a locally produced document can be available for the entire organisation. Such awareness can be established during training sessions, newsletters or by using other information channels. In particular, actors that often work with confidential/sensitive information should receive additional training in order to ensure that the consequences of wrong information classification are understood. That having been said, training can prevent some though not all side effects. Managing confidential/sensitive information poses a number of challenges. The confidentiality of information is not given, but there are levels of confidentiality which can change over time. For this reason, certain information can be confidential for certain groups, whereas the confidentiality status can change over time. In addition, the rotation of people across projects or even disciplines is quite high in modern large-scale organisations. Moreover, oil and gas companies rely on many vendors and service companies that also need access to certain information for a certain period of time. In short, who has to manage access and how is a highly complex issue that is poorly understood by both management and users.

### 6.3.2 Implications for technology managers

*Radical changes and persistent fragmentation*

Strategic visions for establishing better collaboration across disciplines and ensuring long-term information retention quite often materialise when establishing an integrated information system. When technology is "rolled out" ambitious visions of "seamless integration" are replaced with ongoing challenges and lists of critical and optional modifications. Over time, these visions are silenced or forgotten, while the list of problems grows and a window for "new" ambitious visions emerges. If convincingly framed, they give rise to a "new" socio-technical change.

A retrospective view suggests that the establishment of a collaborative infrastructure in an OGC does not unfold in smooth and continuous cycles, but does so with disruptions and repeated initiatives for achieving a radical change. This reminds one of what Michael Hammer (1990) said more than a decade ago "don't automate, obliterate". In the early 1990s, the intentions to establish Lotus Notes infrastructures were grounded in a vision of achieving a better integration and standardisation (Monteiro & Hepsø, 2000). A decade later, the OGC formulated a new strategy, which suggested that the OGC already possessed a set of general collaborative tools, although "these tools [were] poorly integrated" (OGC strategy documents). In 2010, the OGC management is already planning another strategic change of its collaborative infrastructure, as it appears that a certain amount of "problems" have to accumulate to invoke a change. Notes problem was fragmentation (over 5,000 DB), while the current MS SharePoint's problem is that it cannot be upgraded to new versions due to extensive customisation. Moreover, engineers who manipulate thousands of documents already wonder how many team sites (not Notes DB this time) they will have to navigate across in order to find information a couple years from now. In that respect, a new system is a good system because there are no inconsistencies and fragmentation threats. Yet when a system is filled up with all the necessary information, it becomes a "problem" which results in the temptation to replace it. While it is understandable that management wants to get rid of the "dirt" (Monteiro & Hepsø, 2002) (i.e. fragmentation), it appears that it is not so easy to accomplish because everyday work is messy and "dirt" is an integral part of it. Difficulties in migrating from one system to another result in a growing installation base in which "old" systems are running in parallel. In the OGC's case, the multiple old archives, file servers, Lotus Notes, MS SharePoint and other various local solutions are part of the current collaborative infrastructure.

A longitudinal retrospective indicates that rather than repeatedly aiming to eliminate fragmentation, it is important to recognise its inevitable existence and the means of how to let it flourish. Thus, no system can eliminate different or overlapping work practices, disagreements or even conflicts among disciplines and "miscellaneous" classification categories. It would be wrong to blame a system or assume that it can solve "all" the problems. As argued above, systems are incomplete and partial objects, meaning that a significant amount of "manual" work has to be carried out to enable the sharing of information and make it relevant for action.

*Fitting technology with core work practices*

Rather than focusing on how many users have accepted a system or are satisfied with it, we propose that the attractiveness of an integrated system should be considered in relation to how well it supports core work practices. In the OGC, core work practices relate to oil and gas production. Multiple disciplines are working with various aspects of the wells, yet the common feature of their work is that they manipulate vast amounts of information. The core question, then, is how an integrated system (MS SharePoint in this case) supports the manipulation of large amounts of documents? The answer unfortunately appears to be not so well. Engineers refer to team sites as large "pools" filled with small post-it notes, yet few effective tools for finding the post-it notes are provided. Technically, the functionality offers multiple sorting, filtering and search functionalities, but they are not so intuitive and people spend a significant portion of their time in just finding documents. This leads us to another assumption embedded in large-scale information systems, namely that users should have access to as much information as possible. We have asked multiple engineers to illustrate how they use corporate-wide search engines, and have often witnessed how the search engine retrieves "too many" results, which either creates frustration for the user or requires extensive work in order to improvise a good query and select multiple filters. As a consequence of this, the search engine is primarily used to retrieve general (e.g. related to human resources), not specific (related to oil and production) information. To retrieve information more quickly, engineers create multiple indexes that provide links to multiple documents, systems or team sites and function as "overviews" for a particular project, activity or discipline (see Jarulaitis & Monteiro, 2009 for more details). Therefore, access to less but more relevant information is the preferred solution for disciplines involved in core oil and gas activities.

*Maintaining risks*

Integrated information systems are evaluated by considering the positive effects they can bring such as non-duplicated information, better information availability and easier information exchange. We argue that the "risks" of such systems should be evaluated as well.

Scholars convincingly argue that integrated infrastructures establish dependencies among modules and systems (Hanseth, 2000). This implies that local errors and workarounds are no longer local, but can propagate across the infrastructure and produce spanning effects which can lead to disruptions (Hanseth & Ciborra, 2007). Document classification and access management are vivid examples of how local, small and perhaps at first unimportant activities can produce great effects some time later across contexts. In the OGC case, such negative effects were translated into the availability of confidential information (see Jarulaitis & Monteiro, 2009 for more details). Hence, integrated information systems are "risky" since they offer not only positive effects but the potential for negative ones as well.

Information infrastructures establish not only dependencies across multiple technological systems/modules, but across disciplines as well. In the OGC, the structure of the metadata standard was developed by record information managers (RIM's), although the process owners were delegated with the responsibility of developing the values. In addition, MS SharePoint administrators had to develop custom components in order to visualise metadata in team sites, and the people responsible for the search engine had to make sure that the metadata values were utilised in the indexing profile. Dependencies between these professionals imply that if one is not doing the work, the "usefulness" of the metadata standard as an integrated component is undermined. Moreover, if RIM's want to make a small change by modifying the structure of the metadata standard, this might imply that MS SharePoint and search engine administrators or even process owners will have to make changes as well. In short, this means that a small change can result in a major change.

This leads us to recognise that information infrastructure requires a significant amount of ongoing maintenance work. Maintenance work, however, is not only black boxed in social theory (Graham & Thrift, 2007), but is also underestimated in large-scale organisations. It is wrong to assume that a sophisticated infrastructure is easy to maintain. On the contrary, as the complexity of an infrastructure increases, so does the amount of maintenance work. In order to reduce formal maintenance work, organisations rely on a vision of generic packages, which in theory are easy to implement and update, though our case suggests that maintenance work is not so much eliminated as moved from the IT department to users. Regular users have to improvise, workaround, fix glitches or develop “shadow” systems both within and around a generic package to keep it running. While at first sight an enterprise system might look a generic one, when scratched beneath the surface it is surrounded with a great diversity of user workarounds.

Drawing on Perrow’s (1999) work, one would suggest avoiding complex systems and instead promote the notion of loose coupling. Allowing for non-integrated systems and divergent work practices does not necessarily imply disorder or “chaos”. As we have empirically illustrated (see Jarulaitis & Monteiro, 2010), differences or inconsistencies can be effectively sorted out when needed on an ad hoc basis. Given the extensive maintenance work and possibilities for major disruptions, organisations should carefully consider the attractiveness of integrated technologies. As outlined in section 2.6 integration is a rather temporal achievement by the actors involved. Technically sophisticated infrastructures are indeed important, yet cannot be overestimated, as they are only an element in a larger network.

## 6.4 Implications for users

An integrated system is not a mere technological phenomenon for putting enterprise into a single enterprise system. A more significant agenda behind these systems is the transformation of work practices. The technical changes that the OGC made in the collaborative infrastructure did not produce a radical change for users. Users did not resist technology since they had long experience with various collaborative technologies (cf. Orlikowski, 1992b). MS SharePoint has a different functionality and interface, yet the logic of sharing documents is similar to Notes. The biggest change for users was not MS SharePoint itself, but the way it was configured together with the metadata standard and the corporate-wide search engine. Together, the combined “package” allows users to search for information from multiple systems (Notes, MS SharePoint, fileservers) and filter it according to various metadata values. Despite this, the new technological functionalities did not produce instant changes. Users had to become acquainted with them, experiment and enact them in practice. In other words, users have to acquire new skills in order to use certain functionalities. For instance, the “successful” use of search engines depends on how a user formulates a query and combines various filters, so it is important to know what to search as well as how to search. A sharp contrast is seen here between users who are used to working with a large amount of documents and ones that use just several team sites. The ones that navigate across many team sites and sort out thousands of documents find it much easier to enact the search engine capabilities.

The search engine has also made users more aware that locally produced information is actually available to all OGC users. In particular, the suspension of search engines has made more users understand the possibilities and risks of the new search engine. Due to increased transparency, some users have restricted access (sometimes too restricted) to certain team sites, even though some have made an additional effort to classify documents as best they can in order to make it easier for others to find them.

Standardisation efforts related to the establishment of the metadata standard have implications for the way people think about information classification and retrieval. While documents were previously stored in folders, a team site now has a single document library in which documents are represented in a “flat” view and the metadata is the primary means of classifying documents, as RIM’s themselves agree that the metadata effort was too much top-down and not very successful. For the majority of the users, it took a while to enact this new logic (Orlikowski, 1992b), and in many cases it implied that users had to use an extensive amount of time to find specific information. Out of all the groups interviewed, well engineers who work across multiple oil and gas fields had a different and more positive attitude towards standardisation efforts. While acknowledging significant differences across oil and gas fields, well engineers argued that it would be much easier for them if at least the most important documents had the same label.

The different users’ practices presented in this research or their critique of a particular feature/functionality should not be interpreted to mean that the user is always correct and the manager is always wrong. Indeed, on some occasions, users’ complaints were overstated. Not all users invest their time in reading training materials or becoming familiar with the various possibilities of technologies. Additionally, some are keen to criticise yet do little to change the existing situation. For this reason, we also suggest that users should take the initiative and engage more actively in technology development. One example of such an engagement was found in an OGP context, in which engineers, secretaries and even managers collectively developed multiple indexes (see Jarulaitis &Monteiro, 2010 for more details). Locally, these indexes are referred to as “best practices”, and represent a good example of how bottom-up classification is developed.

# 7 Concluding remarks

This study has been conducted in an oil and gas company, and aims to investigate how integration efforts unfold within a large organisation and to characterise how working integrated systems are established in practice. The reported research was conducted in a single organisation, yet as stated in the introductory section, the thesis relates to the broader concerns across industries for exploiting integrated systems that would improve collaboration across disciplinary and geographical boundaries. Our empirical material illustrates that integrated systems are important in terms of supporting information sharing practices across disciplines not only here-and-now, but over long time periods as well. Such systems impose a certain level of standardisation which is necessary for sharing information over place and time dimensions, though this does not imply that an organisation becomes homogeneous and its variations are eliminated. Our case shows that in large-scale heterogeneous settings "seamless integration" is difficult to achieve, and even if there is a technical possibility, there is the question of whether it is feasible to aim for it. For example, the OGC started its migration from Lotus Notes in 2005, yet if it takes more than five years to migrate from one (!) system then aiming to seamlessly integrate all information into one system is hardly feasible. A pragmatic balance is then achieved by loosely integrating different systems with the search engine. The case of seamless integration can be further challenged by adding a dozen other specialised systems used in oil and gas production in addition to the ones outlined above. The most striking aspect however is that despite this fragmentation, people quite effectively navigate across systems and share information. The best example in our case is well engineers, who despite differences effectively conduct well interventions across multiple oil and gas fields. Thus, we argue that the need for seamless integration could have been overstated.

The findings produced during this research support Gartner's statements presented in the introductory section that implementing an integrated system translates into significant costs. In terms of work, the costs in our case relate not only to "rolling out" as consultants suggest, but also to continuous and rather unplanned invisible work in order to keep the integrated systems running. The cost is high not only for users, as they have to locally adjust the system, but also for various disciplines that are responsible for managing different components of an integrated solution.

External SOX requirements for establishing a more systematic control of information has been an important factor for the OGC in establishing a more integrated and standardised collaborative infrastructure. While this research did not evaluate whether the OGC has met the SOX requirements, we argue that their intentions to improve long-term information retention using a top-down metadata standard have to be reconsidered. Too much focus on long-term and top-down approaches certainly needs to be de-emphasised and have had negative consequences on here-and-now/ad hoc collaborative practices.

This thesis provides practical considerations for technology managers in general and information records managers in particular. We argue that records managers should more actively aim to balance top-down and bottom-up approaches and facilitate user tagging activities. The retrospective view on collaborative infrastructure establishment suggests that technology managers' ambitions to eliminate fragmentation with integrated systems are overstated. We propose that fragmentation in large and heterogeneous contexts is an integral part of a working infrastructure and has to be cultivated. In addition, while an integrated collaborative infrastructure can leverage "all" information to "all" users, we find that users prefer to have more narrow overviews of work practice-oriented information. Our findings also suggest that both negative (i.e. spanning, which can lead to disruptions) and positive effects should be evaluated when considering the attractiveness of integrated systems. In short, our work does not suggest that integrated information systems are not appropriate for large-scale heterogeneous organisations, but illustrates the significant and rather unforeseen work needed to help keep them running.

This thesis aims to contribute to the Information Systems field in general and social studies of IS in particular. Inspired by recent discussions on the mediating role of integrated technologies, the thesis develops rich insights on the implementation and use of integrated technologies across different organisational contexts. In particular, the thesis employs a concept of cross-contextual in order to account for technology constraints that span across multiple contexts and work practices that are not local, but which are carried out across several organisational contexts. Our insights suggest that integration is not a stable technological state, but a temporal and performative achievement undertaken by the actors involved. Taken as a whole, the research presented addresses the current theoretical overemphasis that work is a predominantly local affair.

## 7.1 Limitations

Similarly to other interpretive studies, the research conducted here provides empirical insights which could be supplemented in both their depth and breadth.

The collected empirical data illustrates some of the work practices in two organisational contexts, namely R&D and an OGC, although they could have been investigated in more depth. Both of the studied contexts are heterogeneous and include several thousand engineers, of whom only a small part were interviewed and observed. As presented in the methodology section, this research was constrained in terms of access to certain documents, systems and observations. In that sense, our understanding of the presented work practices was dependent on that access. Specifically, there is a need to conduct a more longitudinal study in an OGP context so as to develop a more dynamic understanding of how different disciplines interact with each other over a certain period of time. The need to conduct this study also stems from the fact that a researcher requires a significant investment of time to become familiar with the complexities (terminologies, methods, technologies) of oil and gas production.

The collected empirical material is limited to two organisational contexts and could be supplemented with similar/different work practices in other organisational contexts. Given that both contexts were studied in the same country, additional insights such as cultural differences/similarities could be gained from investigating work practices in other countries. Multiple studies on how the same phenomena (integration) unfold in various contexts would lead to more diverse comparisons and could contribute to new understandings. As presented in the methodology section, the site selection followed "planned opportunism"; as a result, different interpretations could be constructed in other organisational contexts. The study of LWI practices is different in this case, as they were "strategically" chosen in order to discuss the non-local aspects of work.

The empirical focus of this research was on work practices and the collaborative infrastructure, yet towards the end of the research, particularly when exploring LWI practices, the boundaries of collaborative infrastructure started to blur. A reader might interpret this as inconsistency, but we argue that this is a finding in itself which shows that what counts as a "collaborative" infrastructure is not given. Hence, the overlaps across systems could be investigated in more detail. Overall, the reported research is a collective and interpretive product. The interpretations developed in this thesis are not absolute, but are grounded in qualitative empirical data and related to current social studies of IS. In the hands of other researchers, or supplemented with different empirical data and theories, other interpretations could emerge.

## 7.2 Future work

Given the widespread concern across industries to establish better integrated information infrastructures though apparently lacking the theoretical understanding on how such systems work, several suggestions for further research are proposed. Firstly, despite the “localist” accounts, our study demonstrates how similar work is conducted across different organisational contexts. Further conceptualisations and empirical examples are needed in order to develop a better of understanding how cross-contextual work practices are or fail to be established. Secondly, the reported research aimed at understanding how large-scale integrated systems become working systems. The emphasis here is that researchers should get closer to practice and develop not only theoretical contributions, but practically relevant results as well. From that perspective, interpretive studies should perhaps be blended with action research and employ multi-method strategies. Thirdly, the majority of IS studies provide snapshots on similar or different phenomena, yet a significant challenge is how to connect different studies in order to develop an in-depth understanding of a given phenomenon over time. The biographical approach recently proposed by Pollock and Williams (2009) is especially relevant in this case. While their study focuses on the on innofusion of enterprise systems, other interesting objects can be studied with such an approach as well. In the oil and gas industry, such an object is a well. This object is “interesting” because it is not single but multiple, and is maintained by multiple communities, supported with various IS and has a long life. Studying how multiple communities work around such objects over a period of many years can provide valuable conceptualisations on how integration is achieved in practice. In a similar manner, other sectors such as healthcare can provide important insights on how integration unfolds across the dimensions of time and space.

## References

Andriessen, J. H. E., Hettinga, M., & Wulf, V. (2003). Introduction to Special Issue on Evolving Use of Groupware. *Computer Supported Cooperative Work (CSCW), 12*(4), 367-380.

Avison, D. E., & Myers, M. D. (2002). *Qualitative research in information systems: a reader*. London: Sage.

Azad, B., & King, N. (2008). Enacting computer workaround practices within a medication dispensing system. *European Journal of Information Systems, 17*(3), 264-278.

Baker, K., & Bowker, G. C. (2007). Information ecology: open system environment for data, memories, and knowing. *Journal of Intelligent Information Systems, 29*(1), 127-144.

Bannon, L., & Bødker, S. (1997). Constructing Common Information Spaces. In J. A. Hughes, W. Prinz, T. Rodden & K. Schmidt (Eds.), *ECSCW '97. Proceedings of the Fifth European Conference on Computer-Supported Cooperative Work, September 1997, Lancaster, UK* (pp. 81-96). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Barley, S. (1986). Technology as an Occasion for Structuring: Evidence from Observation of CT Scanners and the Social Order of Radiology Departments. *Administrative Science Quarterly, 31*(1), 78-109.

Barrett, M., & Walsham, G. (1999). Electronic Trading and Work Transformation in the London Insurance Market. *Information Systems Research, 10*(1), 1 - 22.

Beck, U., Giddens, A., & Lash, S. (1994). *Reflexive modernization: politics, tradition and aesthetics in the modern social order*. Cambridge: Polity Press.

Berg, M. (1999). Accumulating and Coordinating: Occasions for Information Technologies in Medical Work. *Computuer Supported Cooperative Work, 8*(4), 373-401.

Berg, M., & Timmermans, S. (2000). Order and Their Others: On the Constitution of Universalities in Medical Work. *Configurations, 8*(1), 31-61.

Bijker, W. E. (1992). The Social Construction of Flourescent Lightning, Or How an Artifact Was Invented in Its Diffusion Stage. In W. E. Bijker & J. Law (Eds.), *Shaping technology/building society: studies in sociotechnical change* (pp. 75-102). Cambridge, Mass.: MIT Press.

Boast, R., Bravo, M., & Srinivasan, R. (2007). Return to Babel: Emergent Diversity, Digital Resources, and Local Knowledge. *Information Society, 23*(5).

Boland, R. J., Jr. (2005). Interpretation and theory in qualitative research. In R. Solli, S. Tengblad & B. Czarniawska (Eds.), *The art of science* (pp. 219-236). Malmö: Liber.

Boudreau, M.-C., & Robey, D. (2005). Enacting Integrated Information Technology: A Human Agency Perspective. *Organization Science, 16*(1), 3-18.

Bowker, G. C., & Star, S. L. (1999). *Sorting things out classification and its consequences*. Cambridge, Mass.: MIT Press.

Carlile, P. R. (2004). Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries. *Organization Science, 15*(5), 555-568.

Carlsson, S. A. (2003). *Critical Realism: A Way Forward in IS Research.* Paper presented at the 11th European Conference on Information Systems, Naples, Italy.

Chu, T., & Robey, D. (2008). Explaining changes in learning and work practice following the adoption of online learning: a human agency perspective. *European Journal of Information Systems, 17*(1).

Ciborra, C. U. (1996). *Groupware and teamwork : invisible aid or technical hindrance?* Chichester: John Wiley.

Ciborra, C. U. (2002). *The labyrinths of information: challenging the wisdom of systems*. Oxford: Oxford University Press.

Ciborra, C. U. (2005). Interpreting e-government and development: Efficiency, transparency or governance at a distance? *Information Technology & People, 18*(3), 260.

Ciborra, C. U., Braa, K., Cordelia, A., Dahlbom, B., Failla, A., Hanseth, O., et al. (2000). *From control to drift : the dynamics of corporate information infastructures*. Oxford: Oxford University Press.

Clegg, C., Axtell, C., Damodaran, L., Farbey, B., Hull, R., Lloyd-Jones, R., et al. (1997). Information technology: a study of performance and the role of human and organizational factors. *Ergonomics, 40*(9), 851-871.

Davenport, T. H. (1998). Putting the enterprise into the enterprise system. *Harvard Business Review, 76*(4), 121-131.

de Laet, M., & Mol, A. (2000). The Zimbabwe Bush Pump: Mechanics of a Fluid Technology. *Social Studies of Science, 30*(2), 225-263.

Edwards, P. N., Bowker, G. C., Jackson, S. J., & Williams, R. (2009). Introduction: An Agenda for Infrastructure Studies. *Journal of the Association for Information Systems, 10*(5), 364-374.

Edwards, P. N., Jackson, S. J., Bowker, G. C., & Knobel, C. P. (2007). Report of a Workshop on "History & Theory of Infrastructure: Lessons for New Scientific Cyberinfrastructures".

Ellingsen, G., & Monteiro, E. (2003). A Patchwork Planet: Integration and Cooperation in Hospitals. *Computer Supported Cooperative Work, 12*, 71-95.

Ellingsen, G., & Monteiro, E. (2006). Seamless Integration: Standardisation across Multiple Local Settings. *Computer Supported Cooperative Work, V15*(5), 443-466.

Fleck, J. (1994). Learning by trying: The implementation of configurational technology. *Research Policy, 23*(6), 637-652.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry, 12*(2), 219-245.

Gartner. (2008). Magic Quadrant for Enterprise Content Management.

Gasser, L. (1986). The Integration of Computing and Routine Work. *ACM Transactions on Office Information Systems, 4*(3), 205-225.

Graham, S., & Thrift, N. (2007). Out of Order: Understanding Repair and Maintenance. *Theory, Culture & Society, 24*(3), 1-25.

Grisot, M. (2008). *Foregrounding differences: a performative approach to the coordination of distributed work and information infrastructures in use.* PhD Thesis, University of Oslo, Oslo.

Grudin, J. (1989). Why Groupware Applications Fail: Problems in Design and Evaluation. *Information Technology & People, 4*(3), 245-264.

Gulledge, T. (2006). What is integration? *Industrial Management + Data Systems, 106*(1/2), 5 - 20.

Hammer, M. (1990). Reengineering Work: Don't Automate, Obliterate. *Harvard Business Review, July-August*, 104-112.

Hanseth, O. (2000). The Economics of Standards. In C. U. Ciborra, et. al (Ed.), *From control to drift: the dynamics of coporate information infrastructures* (pp. 56-71). Oxford: Oxford University Press.

Hanseth, O. (2001). Gateways—just as important as standards: How the internet won the "religious war" over standards in Scandinavia. *Knowledge, Technology & Policy, 14*(3), 71-89.

Hanseth, O., & Braa, K. (2001). Hunting for the Treasure at the End of the Rainbow: Standardizing corporate IT Infrastructure. *Computer Supported Cooperative Work (CSCW), 10*(3), 261-292.

Hanseth, O., & Ciborra, C. U. (2007). *Risk, complexity, and ICT*. Northampton, MA: Elgar.

Hanseth, O., Ciborra, C. U., & Braa, K. (2001). The Control Devolution ERP and the Side-effects of Globalization. *The Data base for advances in information systems, 32*(4), 34-46.

Hanseth, O., Jacucci, E., Grisot, M., & Aanestad, M. (2006). Reflexive Standardization: Side Effects and Complexity in Standard Making. *MIS Quarterly, 30*, 563-581.

Hanseth, O., Jacucci, E., Grisot, M., & Aanestad, M. (2007). Reflexive integration in the development and implementation of an Electronic Patient Record system. In O. Hanseth & C. U. Ciborra (Eds.), *Risk, complexity, and ICT* (pp. 118-135). Northampton, MA: Elgar.

Hanseth, O., & Monteiro, E. (1997). Inscribing behaviour in information infrastructure standards. *Accounting, Management and Information Technologies, 7*(4), 183-211.

Hanseth, O., & Monteiro, E. (1998). *Understanding Information Infrastructure*. Unpublished manuscript. University of Oslo, Oslo, Norway. Retrieved from http://heim.ifi.uio.no/~oleha/Publications/bok.html

Hasselbring, W. (2000). Information Systems Integration. *Communications of the ACM, 43(6)*, 32-38.

Henriksen, H. Z., & Kautz, K. (2006). *An Analysis of IFIP TC 8 WG 8.6 – In Search for a Common Theoretical Denominator.* Paper presented at the "The Past and Future of Information Systems: 1976-2006 and beyond", August 21 -23, Santigo, Chile

Hepsø, V., Monteiro, E., & Rolland, K. H. (2009). Ecologies of e-Infrastructures. *Journal of the Association for Information Systems, 10*(5), 430-446.

Hjelle, T., & Jarulaitis, G. (2008). *Changing Large-Scale Collaborative Spaces: Strategies and Challenges.* Paper presented at the 41st Hawaii International Conference on System Sciences, Hawaii.

Howcroft, D., & Trauth, E. M. (2005). *Handbook of critical information systems research : theory and application*. Northampton, Mass.: E. Elgar Pub.

Hughes, J., & Jones, S. (2004). Reflections on the use of Grounded Theory in Interpretive Information Systems Research. *Electronic Journal of Information Systems Evaluation, 6*(1).

Hughes, T. P. (1987). The Evolution of Large Technical Systems. In T. Pinch & W. E. Bijker (Eds.), *The Social construction of technological systems new directions in the sociology and history of technology* (pp. 51-82). Cambridge, Mass.: MIT Press.

Industry Directions Inc. (2004). Sarbanes-Oxley Compliance: Benefiting from the Mandate Retrieved August 2010, from https://www-304.ibm.com/businesscenter/cpe/download2/33075/sox.pdf

Jarulaitis, G. (2010). *The Uneven Diffusion of Collaborative Technology in a Large Organisation*. Paper presented at the IFIP WG 8.2 + 8.6 Joint International Working Conference, Perth, Australia.

Jarulaitis, G., & Hepsø, V. (2010). Cross-contextual work practice: Investigating strategies for navigating across islands of knowledge. *Submitted for review*.

Jarulaitis, G., & Monteiro, E. (2009). *Cross-contextual use of integrated information systems.* Paper presented at the 17th European Conference on Information Systems, Verona, Italy.

Jarulaitis, G., & Monteiro, E. (2010). *Unity in Multiplicity: Towards Working Enterprise Systems.* Paper presented at the 18th European Conference on Information Systems Pretoria, South Africa.

Jones, M., & Orlikowski, W. J. (2007). Information technology and the dynamics of organizational change. In R. Mansell, C. Avgerou, D. Quah & R. Silverstone (Eds.), *The Oxford handbook of information and communication technologies* (pp. 293-313). Oxford ; New York: Oxford University Press.

Joshi, S., Barrett, M., & Walsham, G. (2007). Balancing local knowledge within global organisations through computer-based systems: an activity theory approach. *Journal of Global Information Management, 15*(3), 1-19.

Kallinikos, J. (2004). Farewell to Constructivism: Technology and Context-Embedded Action. In F. Land, C. Avgerou & C. U. Ciborra (Eds.), *The Social study of information and communication technology : innovation, actors, and contexts* (pp. 140-161). Oxford: Oxford University Press.

King, J. L., & Lyytinen, K. (2006). *Information Systems: The State of the Field.* Chichester: Wiley.

Klein, H. K., & Myers, M. D. (1999). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly, 23*(1), 67 - 93.

Knorr Cetina, K. (2001). Objectual practice. In E. v. Savigny, K. Knorr Cetina & T. R. Schatzki (Eds.), *The Practice turn in contemporary theory* (pp. 175-188): Routledge.

Lærum, H., Ellingsen, G., & Faxvaag, A. (2001). Doctors' use of electronic medical records systems in hospitals: cross sectional survey. *British Medical Journal, 323*, 1344-1348.

Law, J. (1994). *Organizing modernity*. Oxford: Blackwell.

Law, J., & Mol, A. (2002). *Complexities: social studies of knowledge practices*. Durham, N.C.: Duke University Press.

Law, J., & Singleton, V. (2000). Performing Technology's Stories: On Social Constructivism, Performance, and Performativity. *Technology and Culture, 41.4*, 765-775.

Lee, J., Siau, K., & Hong, S. (2003). Enterprise integration with ERP and EAI. *Association for Computing Machinery. Communications of the ACM, 46*(2), 54 - 60.

Leonardi, P. M., & Barley, S. R. (2008). Materiality and change: Challenges to building better theory about technology and organizing. *Information and Organization, 18*(3), 159-176.

Levina, N., & Vaast, E. (2005). The Emergence of Boundary Spanning Competence In Practice: Implications For Implementation and Use of Information Systems. *MIS Quarterly, 29*(2), 335-363.

Linthicum, D. S. (2004). *Next generation application integration : from simple information to Web services*. Boston, Mass.: Addison-Wesley.

MacKenzie, D., & Wajcman, J. (1999). *The Social shaping of technology*. Maidenhead: Open University Press.

Marcus, G. E. (1995). Ethnography in/of the World System: The Emergence of Multi-Sited Ethnography. *Annual Review of Anthropology, 24*, 95-117.

Mark, G. (2002). Conventions and Commitments in Distributed CSCW Groups. *Computer Supported Cooperative Work (CSCW), 11*(3), 349-387.

Mason, R. O., McKenney, J. L., & Copeland, D. G. (1997). Developing an historical tradition in MIS research. *MIS Quarterly, 21*(3), 257-278.

Mendoza, L. E., Pérez, M., & Grimán, A. (2006). Critical Success Factors for Managing Systems Integration. *Information Systems Management, 23*(2), 56-75.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*: SAGE Publications.

Mol, A. (2003). *The body multiple : ontology in medical practice*. Durham: Duke University Press.

Monteiro, E. (2000). Actor-Network Theory and Information Infrastructure. In e. a. Ciborra (Ed.), *From control to drift: the dynamics of corporate information infrastructures* (pp. 71-83). Oxford: Oxford University Press.

Monteiro, E., & Hanseth, O. (1995). Social shaping of information infrastructure: on being specific about the technology. In W. Orlikowski (Ed.), *Information technology and changes in organizational work* (pp. 325-343): Chapman & Hall.

Monteiro, E., & Hepsø, V. (2000). Infrastructure Strategy Formation: Seize the Day at Statoil. In e. a. Ciborra (Ed.), *From control to drift: the dynamics of corporate information infrastructures* (pp. 148-172). Oxford: Oxford University Press.

Monteiro, E., & Hepsø, V. (2002). Purity and Danger of an Information Infrastructure. *Systemic Practice and Action Research, 15*(2), 145-167.

Nah, F. F.-H., Lau, J. L.-S., & Kuang, J. (2001). Critical factors for successful implementation of enterprise systems. *Business Process Management Journal, 7*(3), 285-296.

Nardi, B. A., & O'Day, V. L. (1999). *Information ecologies: using technology with heart*. Cambridge, Mass.: MIT Press.

OLF. (2006). Potential value of Integrated Operations on the Norwegian Shelf Retrieved August 2010, from http://www.olf.no/getfile.php/zKonvertert/www.olf.no/Rapporter/Dokumenter/070115%20-%20IO%20og%20HMS_5778.pdf

Orlikowski, W. J. (1992a). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science, 3*(3), 398-427.

Orlikowski, W. J. (1992b). *Learning from Notes: organizational issues in groupware implementation*. Paper presented at the ACM conference on Computer-supported cooperative work, Toronto, Ontario, Canada.

Orlikowski, W. J. (1993). CASE tools as organizational change: Investigating incremental and radical changes in systems development. *MIS Quarterly, 17*(3), 309-340.

Orlikowski, W. J. (1996). Improvising Organizational Transformation Over Time: A Situated Change Perspective. *Information Systems Research, 7*(1), 63-92.

Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization Science, 11*(4), 404-428.

Orlikowski, W. J., & Baroudi, J. J. (1991). Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research, 2*, 1-28.

Orlikowski, W. J., & Gash, D. C. (1994). Technological frames: making sense of information technology in organizations. *ACM Transactions on Information Systems, 12*(2), 174-207.

Orlikowski, W. J., & Iacono, C. S. (2001). Research Commentary: Desperately Seeking the 'IT' in IT Research-A Call to Theorizing the IT Artifact. *Information Systems Research, 12*(2), 121-134.

Orlikowski, W. J., & Robey, D. (1991). Information Technology and the Structuring of Organizations. *Information Systems Research, 2*(2), 143-169.

Orlikowski, W. J., & Scott, S. V. (2008). Sociomateriality: Challenging the separation of technology, work and organization. *Academy of Management Annals, 2*(1), 433-474.

Orr, J. E. (1996). *Talking about machines an ethnography of a modern job*. Ithaca, N.Y.: Cornell University Press.

Perrow, C. (1999). *Normal accidents: Living with high-risk technologies*. Princeton, N.J.: Princeton University Press.

Pinch, T., & Bijker, W. E. (1987). The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other. In W. E. Bijker, T. P. Hughes & T. J. Pinch (Eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (pp. 17-50). Cambridge, MA: MIT Press.

Pinch, T., Bijker, W. E., & Hughes, T. P. (1987). *The Social construction of technological systems new directions in the sociology and history of technology*. Cambridge, Mass.: MIT Press.

Pollock, N., & Williams, R. (2009). *Software and Organizations. The biography of the enterprise-wide system or how SAP conquered the world*: Routledge.

Pollock, N., Williams, R., & D'Adderio, L. (2007). Global software and its provenance: Generification work in the production of organizational software packages. *Social Studies of Science, 37*(2), 254-280.

Pollock, N., Williams, R., D'Adderio, L., & Grimm, C. (2009). Post local forms of repair: The (extended) situation of virtualised technical support. *Information and Organization, 19*(4), 253-276.

Pollock, N., Williams, R., & Procter, R. (2003). Fitting standard software packages to non-standard organizations: The "biography" of an enterprise-wide system. *Technology Analysis & Strategic Management, 15*(3), 317-332.

Quattrone, P., & Hopper, T. (2006). What is IT?: SAP, accounting, and visibility in a multinational organisation. *Information and Organization, 16*(3), 212-250.

Randall, S. (2000). *What's Common about Common Information Spaces?.* . Paper presented at the Workshop on Cooperative Organisation of Common Information Spaces, Technical University of Denmark. http://www.itu.dk/people/schmidt/ciscph2000/Randall.pdf

Robey, D., & Boudreau, M.-C. (1999). Accounting for the Contradictory Organizational Consequences of Information Technology: Theoretical Directions and Methodological Implications. *Information Systems Research, 10*(2), 167-185.

Robey, D., & Sahay, S. (1996). Transforming work through information technology: A comparative case study of geographic information systems in county government. *Information Systems Research, 7*(1), 93-110.

Rolland, K. H., Hepsø, V., & Monteiro, E. (2006). *Conceptualizing common information spaces across heterogeneous contexts: mutable mobiles and side-effects of integration.* Paper presented at the ACM conference on Computer supported cooperative work, Banff, Canada.

Rolland, K. H., & Monteiro, E. (2002). Balancing the local and the global in infrastructural information systems. *Information Society, 18*(2), 87-100.

Rolland, K. H., & Monteiro, E. (2007). When 'perfect' integration leads to increasing risks: the case of an integrated information system in a global company. In O. Hanseth & C. U. Ciborra (Eds.), *Risk, complexity, and ICT* (pp. 97-117). Northampton, MA: Elgar.

Sahay, S., Monteiro, E., & Aanestad, M. (2009). Configurable Politics and Asymmetric Integration: Health e-Infrastructures in India. *Journal of the Association for Information Systems, 10*(5), 399-414.

Schmidt, K., & Bannon, L. (1992). Taking CSCW Seriously: Supporting Articulation Work *CSCW: An International Journal, 1(1-2)*, 7-40.

Schultze, U. (2000). A Confessional Account of an Ethnography about Knowledge Work. *MIS Quarterly, 24*(1), 3-39.

Schultze, U. (2001). Reflexive Ethnography in Information Systems Research. In E. M. Trauth (Ed.), *Qualitative research in IS issues and trends* (pp. 78-103). Hershey, Pa.: Idea Group Publishing.

Shapin, S. (1995). Here and Everywhere: Sociology of Scientific Knowledge. *Annual Review of Sociology, Vol. 21*, 289-321.

Sismondo, S. (2004). *An introduction to science and technology studies*: Blackwell Publishing.

Smith, M. R. (1994). Technological Determinism in American Culture. In M. R. Smith & L. Marx (Eds.), *Does technology drive history? : the dilemma of technological determinism* (pp. 2-35).

Smith, M. R., & Marx, L. (1994). *Does technology drive history? : the dilemma of technological determinism*.

Soh, C., Kien, S. S., & Tay-Yap, J. (2000). Cultural fits and misfits: Is ERP a universal solution? *Association for Computing Machinery. Communications of the ACM, 43*(4), 47 - 51.

Star, S. L. (1999). The Ethnography of Infrastructure. *American Behavioral Scientist, 43*(3), 377-391.

Star, S. L., & Griesemer, J. R. (1989). Institutional Ecology, Translations and Boundary Objects - Amateurs and Professionals in Berkeleys-Museum-of-Vertebrate-Zoology, 1907-39. *Social Studies of Science, 19*(3), 387-420.

Star, S. L., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information Systems Research, 7*(1), 111-134.

Suchman, L. A. (1987). *Plans and situated actions : the problem of human-machine communication*. Cambridge: Cambridge University Press.

Suchman, L. A. (2007). *Human-machine reconfigurations : plans and situated actions* (2nd ed.). Cambridge: Cambridge University Press.

Timmermans, S., & Berg, M. (1997). Standardization in action: Achieving universalism and localisation through medical protocols. *Social Studies of Science, 27*(1), 273-305.

Turnbull, D. (2000). *Masons, tricksters and cartographers : comparative studies in the sociology of scientific and indigenous knowledge*: Amsterdam : Harwood Academic.

Urquhart, C. (2001). An Encounter with Grounded Theory: Tackling the Practical and Philosophical Issues. In E. M. Trauth (Ed.), *Qualitative Research in IS: Issues and Trends*.

Vaast, E., & Walsham, G. (2009). Trans-Situated Learning: Supporting a Network of Practice with an Information Infrastructure. *Information Systems Research, 20*(4), 547-564.

Van Maanen, J. (1988). *Tales of the field: on writing ethnography*. Chicago: University of Chicago Press.

Volkoff, O., Strong, D. M., & Elmes, M. B. (2005). Understanding enterprise systems-enabled integration. *European Journal of Information Systems, 14*(2), 110 - 120.

Wagner, E. L., & Newell, S. (2004). 'Best' for whom?: the tension between 'best practice' ERP packages and diverse epistemic cultures in a university context. *The Journal of Strategic Information Systems, 13*(4), 305-328.

Wainwright, D., & Waring, T. (2004). Three domains for implementing integrated information systems: redressing the balance between technology, strategic and organisational analysis. *International Journal of Information Management, 24*(4).

Walsham, G. (1993). *Interpreting information systems in organizations*. Chichester: Wiley.

Walsham, G. (1995). Interpretive case studies in IS research: Nature and method. *European Journal of Information Systems, 4*(2), 74–81.

Walsham, G. (2005). Learning about being critical. *Information Systems Journal, 15*(2), 111–117.

Walsham, G. (2006). Doing interpretive research. *European Journal of Information Systems, 15*(3), 320-330.

Walsham, G., & Sahay, S. (1999). GIS for District-Level Administration in India: Problems and Opportunities. *MIS Quarterly, 23*(1), 39-65.

Weber, R. (2003). Still Desperately Seeking the IT Artifact. *MIS Quarterly, 27*(2), iii-xi.

Yin, R. K. (2002). *Case study research, 3rd ed*. Newbury Park: Sage Publications.

## Appendix: The Papers

PAPER ONE: Changing Large-Scale Collaborative Spaces: Strategies and Challenges

PAPER TWO: Cross-contextual use of integrated information systems

PAPER THREE: The Uneven Diffusion of Collaborative Technology in a Large Organisation

PAPER FOUR: Unity in Multiplicity: Towards Working Enterprise Systems

PAPER FIVE: Cross-contextual work practice: Investigating strategies for navigating across islands of knowledge

# Paper one

Hjelle, T., & Jarulaitis, G. (2008). *Changing Large-Scale Collaborative Spaces: Strategies and Challenges*. Paper presented at the 41st Hawaii International Conference on System Sciences, Hawaii.

# Changing Large-Scale Collaborative Spaces: Strategies and Challenges

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## Abstract

*Introducing new collaboration tools in an organization is difficult and will most often cause side-effects and unforeseen concequences. In this paper we use the concept of Common Information Spaces (CIS) to analyze how information is shared within a large organization. We draw on findings from a large, international oil and gas company to analyze the the implementation of a Microsoft SharePoint based collaboration system within the organization. Analytically we discuss the drifting nature of large-scale efforts to establish a company-wide centralized and tightly integrated CIS. Acknowledging that introducing information systems that instigate changes in work practices are inherently difficult within any organization, and even more so in large enterprise organizations, combined with the diversed perspectives on how to establish CIS within the existing literature we characterize large-scale common information spaces and identify directions for further research.*

## 1. Introduction

Today, organizations have to transfer information and share knowledge across geographical and organizational boundaries. It is widely assumed that integration of a fragmented infrastructure is a prerequisite rather than an option to achieve such vision. Despite the existing variety of technological techniques [11], integration activities tend to display emergent properties [29]. According to Kuldeep et al. [8, p.23] "integration has been the holy grail of MIS since the early days of computing in organizations". This argument is continually supported with empirical studies from various industries, such as health care [5], ship classification [21], e-government [3], and oil and gas industry [12].

In this paper we employ the concept of common information space (CIS), which is extensively used within the field of Computer Supported Cooperative Work (CSCW) to analyze how actors jointly construct various socio-technical arrangements in order to share information across organizational boundaries. The crucial aspect of CIS is not a seamlessly integrated technological environment, but continuous interpretation work [22]. Consequently, the concept challenges taken-for-granted assumptions of achievable seamless integration: "the notion of 'a uniform, complete, consistent, up-to-date integration' of the knowledge in a community handbook is hardly realistic" [22, p.24]. As such, the concept enables analyzes of how integration activities unfold in practice.

Our research is motivated by a resent call to explore the dynamics of large-scale common information spaces [20]. We draw on diverse literature on CIS and discuss such aspects as the role of interpretation work [22], openness and closure [1] and heterogeneity [2]. Additionally, we discuss the nondeterministic character of IS implementation processes [19] and how initial plans drift in practice [4]. Furthermore we adopt the concept of *uncertainty*, which derives from a recent contribution by Latour [9]. The author vividly conceptualizes inherent uncertainties stemming from an endless web of mediators, where mediators "transform, translate, distort, and modify the meaning or the elements they are supposed to carry" [9, p.39]. We use this concept to expose and discuss inherent uncertainties, rather than rational planning with predictable consequences, in establishing large-scale CIS.

Empirically we illustrate integration activities within a large international oil and gas company (dubbed OGC). Our research is part of a larger, internal OGC project aiming at improving oil and gas production optimization activities. We zoom-in and unpack the (re)establishment of the collaborative infrastructure. The old collaborative infrastructure was based on Lotus Notes technologies and aimed to increase organization-wide standardization and cost-effectiveness [13]. This vision resulted in more than 5000(!) unsynchronized databases and an even more fragmented infrastructure. In order to increase consistency, remove fragmentation and ease both information retrieval and sharing, a new collaboration strategy was launched. The material outcome of this strategy was the implementation of a new collaborative infrastructure based on Microsoft SharePoint technologies. Findings from our ongoing research suggest that the new infrastructure constrain institutionalized work practices and tend to produce side effects [14]. Thus, the main purpose of this paper is to characterize large-scale common information spaces in an oil and gas company, and identify directions for further research.

1530-1605/08 $25.00  

The paper is organized as follows: We start off with a brief description of the history of CIS and identify some important contributions in the area. We then look into some possible problems that can arise when introducing new information systems, that is, unforeseen consequences, before we investigate the role of plans and strategies when introducing new IS tools. Then an outline of our research approach follows, before we introduce the case in context. Following this is a discussion of the case in contrast to the existing literature before we round off with a brief section describing our future research direction as well as a few concluding remarks.

## 2. Conceptualizing common information spaces

The concept of common information spaces was originally formulated by Schmidt and Bannon [22] to bring focus on an area of "critical importance for the accomplishment of many distributed work activities" [22, p.16] as they believe the area has been neglected within CSCW. CIS is offered as an alternative to the so-called 'workflow' perspective, where every actor's actions can be predefined in advance. The authors draw on Suchman [25] and highlight that in contexts where continuous negotiation and problem solving is required, 'workflow' perspective fails to explain how work is done in practice. Consequently, they argue for an alternative approach, which would "allow the members of a cooperating ensemble to interact freely" [22, p.20]. They argue that cooperative work is not facilitated merely through access to information in a shared database, but also require a shared understanding of the meaning of this information, as the information always has to be interpreted by human actors. Then they introduce the concept of common information spaces, which seeks to explain how people in a distributed setting are able to work cooperatively through access to common organizational information and a shared understanding of the 'meaning' of this information: "a common information space encompasses the artifacts that are accessible to a cooperative ensemble *as well as* the meaning attributed to these artifacts by the actors" [22, p.21]. While interpretation work and construction of a particular object's 'meaning' is situation dependent, and determined locally within a given context, the coherence is crucial: "in order for work to be accomplished, these personal, or local information spaces must cohere, at least temporarily" [22, p.21].

Bannon and Bødker [1] build on this concept and investigate the dialectic nature of CIS. They acknowledge that there are many forms of common information spaces. Sometimes common information spaces are comprised of people working at the same time and place, while other times people collaborate across both time and space boundaries. Though there are various forms of CIS, they recognize that common information spaces have some common identifying properties. In order to conceptualize large-scale CIS authors draw on science and technology studies (STS) and identify such concepts as 'immutable mobile' and 'boundary object', which "both can be viewed as being concerned with how communities develop means for sharing items in a common information space" [1, p.84]. Additionally, authors highlight the relevance of the "community of practice" perspective developed by Lave and Wenger [10] in order to indicate learning and working environments. The central issue then becomes whether information should be circulated within or across communities of practice. In other words, to what extent local information should be malleable and at the same time 'packaged' to have a 'common' meaning in different contexts. Following these conceptualizations Bannon and Bødker [1] identify the dialectical nature of CIS:

> "It is this tension between the need for openness and malleability of information on the one hand, and, on the other, the need for some form of closure, to allow for forms of translation and portability between communities, that we believe characterizes the nature of common information spaces, and leads to difficulties in their characterization. CISs are both open and closed – in a word, the have a dialectical nature" [1, p.85]

Bannon and Bødker [1] illustrate the dialectical nature of CIS with several empirical examples. At one end of the spectrum they discuss coordination rooms where co-located actors manipulate malleable CIS. At the other end, they expose a heterogeneous large-scale CIS, the WWW, inherently uncertain and dialectical.

Bossen [2] proposes a refinement of the concept of common information spaces and proposes a conceptual framework to analyze cooperative work. His framework is developed through the analyses of CIS in a hospital ward and results in the identification of 7 parameters he argues is useful in order to position a given CIS. Bossen acknowledges that "it is doubtful whether it will be possible to generate a distinct categorization, i.e. typology, through which specific work settings can be categorized into particular types of CIS" [2, p.185]. He therefore suggests, "it might be better to have a framework through which specific settings can be analyzed" [2, p.185].

Randall [18] is critical to the idea of commonality within CIS. He claims that "the very notion of CIS is radically underspecified" [18, p.17] as, he continues, "it is not possible to distinguish its putative features by reference to technology, to information or to organizational structure" [18, p.17]. The problems with classifying CIS occur in part because CIS ranges "from shared, small groups to complex inter-organizational chains" [18, p.17]. Because "we have to deal with issues that arise out of the complex historical and geographically dispersed range of information resources that might be in use in the large organization, or indeed across different organizations" [18, p.17], it is problematic to identify exactly what is common across various work practices.

Rolland, Hepsø et al. [20] conducted a study of different common information spaces in a major international oil and gas company as well, and their findings suggested that some common information spaces appear to be more situated, momentary and malleable when embedded within an extremely heterogeneous context. They end their paper by acknowledging the "need for more research on large-scale collaborative systems in order to improve current conceptualizations of CIS" [20, p.499]. This is because "most studies within CSCW have been focusing on relatively small-scale systems involving a limited group of users collaborating over small distances" [20, p.499].

## 3. Research approach and data collection

In our ongoing research project we are aiming to study the transition process from Lotus Notes to MS SharePoint technologies in OGC. We are studying both technological and social complexity and investigate "the interaction between the engineering detail of the technical systems and the related dynamics of the surrounding social arrangements" [4, p.3]. We conceptualize our research as an interpretive case study [26] as we do not predefine dependent and independent variables and "attempt to understand phenomena through the meanings that people assign to them" [7, p.69].

We conceptualize our research design as emergent rather than highly structured. We lean towards an inductive approach and identify grounded theory [15] and ethnography-informed [24] studies as relevant approaches to explore IS implementation activities in real-world contexts, and build our theoretical perspectives on empirical data, rather than analytical constructs.

Data collection and fieldwork started in the beginning of 2007. Since then, we have conducted seven interviews with OGC representatives, who mainly represent the so-called management perspective. The interviews lasted from one to several hours. The first interviews were more open-ended with the primary focus on current OGC initiatives and plans regarding the use of MS SharePoint technologies. Latter interviews were more focused on both technological complexity and interdisciplinary work practices. Besides that, we have extensively studied various documents, including project plans, reports, various presentations and other related documentation. More than 300 pages were gathered and carefully analyzed. Additionally, we've had the opportunity to study several email discussions related to project planning and execution activities. Recently, we have also been granted access to an extensive information source of OGC activities – the intranet portal. The content of the studied documents and conducted interviews have introduced us to the existing socio-technical complexities, main strategic initiatives with expected deliverables and current problems. Previous studies on implementation and use of Lotus Notes in OGC [8, 14-18] were also carefully studied and analyzed in comparison with current problems and challenges.

Further data collection activities will involve document analysis, participant observation and semi-structured interviews. We aim at obtaining in-depth knowledge of both surrounding socio-technical contexts and the diverse perspectives of various actors.

## 4. Case description

Introducing new systems for computer supported collaborative work is a complicated task in all organizations as it not only introduces new IT tools, but also new ways of working [16]. What makes this even more difficult in large organizations is that they have so many different people working on so many different tasks at a number of different locations. Introducing one single system to support all users at all tasks in all locations is a major challenge.

In 2001, OGC, a major international oil and gas company, that today has about 26 000 employees in 34 countries worldwide, formulated a strategy to improve collaboration within the organization. This strategy focuses on collaboration within the company, and ranges from so-called collaboration rooms, which are dedicated rooms where experts from various disciplines meet, to systems like video conferencing for collaboration between users at various locations to more traditional collaboration ICT-systems. Collaboration can take place between users at the same or different location, and at the same or different time. People wishing to collaborate at the same time can choose to use the collaboration room if they are all at the same location, or they can use a video conference system if they are located at two or more locations. If they want to collaborate at different times – maybe because they are dispersed around the world in different time zones – they can use a more traditional collaboration system.

One of the results of the strategy was the decision to change the collaboration infrastructure. This decision was made in 2003. OGC had up until then been using a system based on Lotus Notes, but after considerable research it was decided to discontinue the use of Lotus Notes and instead implement a new infrastructure based on Microsoft SharePoint technologies. It was believed that this new infrastructure would better suit the management's vision of collaboration within the organization. In addition, the introduction of this new information system was used to catalyst an organizational change.

Due to the size of the organization, as well as the nature of the business, each month OGC creates about 70 000 Word documents, 65 000 Excel spreadsheets, 20 000 PowerPoint presentations and 145 000 non-classified documents. That is about 300 000 new documents each month. Keeping track of all these documents require a robust and scaleable system.

The old Lotus Based collaboration system had a few aspects that were considered unfortunate. First, the Lotus Notes infrastructure had grown out of control. In total the system consisted of more than 5000 different, dispersed Arena databases for document storage. The Arena databases had no central indexing functionality, meaning that it was impossible to retrieve a document by searching if you did not know which database to search. Each user had in addition access to both personal and departmental storage areas. Not all users chose to store their documents in the Arena databases, but instead chose to store it on either of the aforementioned storage areas. This meant that even if it had been possible to search all databases at once, it would not have been successful as not all documents were stored in the databases.

Implementing the Microsoft SharePoint technology was hoped to change the way people worked. According to the strategy, OGC already had a set of general collaboration tools, but “these tools are poorly integrated”, and “there is a particular need for better and more integrated coordination tools, better search functionality and improved possibilities for sharing information with external partners”. (internal strategy documents). The strategy defined the main challenges to be addressed by the new solution to be “information quality, archiving, search/retrieval and proper handling of e-mail”. It was believed that the real benefit of introducing the new infrastructure was that it would change the way people worked. They would work more efficiently. The company acknowledged that introducing the new information system was just a minor part of the strategy. More important was the change of work practices. In one document they emphasize this by claiming that the new strategy would be “80% change - 20% IT” (internal strategy document).

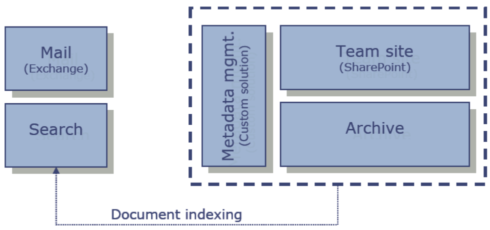


**Figure 1: Integration of collaboration tools**

As indicated by figure 1, MS SharePoint is, together with the metadata management system and the archive, a core element of the new collaboration solution. This solution would then be integrated with OGC’s email system, and their in-house search engine. MS SharePoint is a collaboration system that in addition to being a repository for storing and retrieving documents also has functionality for checking-in and checking-out documents and version tracking; it has web-based discussion boards, as well as features for managing wikis. MS SharePoint can also be linked to email-systems and MS Live Messenger (previously MSN Messenger) for instant messaging.

Central within MS SharePoint is the concept of *Team Sites*. A Team Site is a virtual workspace shared by people working on the same project, in the same department, within the same discipline, etc. The average user will typically be a member of a handful different Team Sites. Typically a Team Site has a limited lifetime and is oriented around a specific task; for instance drilling of a given well. All documents related to the drilling of this well is gathered within this Team Site.

When a project is initiated the project leader will typically have a Team Site created. When creating a Team Site the project manager has to define a set of applicable metadata from a list of available values. The metadata would typically be selected based on what kind of task for which the Team Site was created. When uploading documents to the Team Site later, the members would have to assign metadata from the selected set to the documents to classify the documents for easier retrieval. This use of metadata is not a standard feature of MS SharePoint, but a custom feature added by OGC to give added value. As we will later discuss, this is also a source of problems when using MS SharePoint at OGC.

Today, there are three levels of metadata at OGC. Originally there were only two levels. But a third level was added to try to combat the problems that occurred. The two first layers only allow users to select values from a predefined list using drop-down boxes. The third level uses free text fields, allowing users to define the values they feel appropriate for a given document.

## 5. Analysis: introducing uncertainties

Given our case at OGC we’ve been studying relevant literature within the areas of CSCW and integration to assign meaning to, and build an understanding of, the context. While digging down into the case we have been alternating between understanding the context based on literature, and letting our findings guide our literature search. Through this process we’ve come up with 5 characteristics of large-scale common information spaces that will guide our further research.. These characteristics are described in more detail in the following sections. A summary of these characteristics can be found in table 1.

| Tensions | Characteristics of large-scale CIS in OGC | Further research considerations |
|---|---|---|
| Common space or spaces | Overlapping interdependent CISs | Is it possible to establish one centralized and tightly integrated large-scale CIS in global organization? |
| Objects or socio-technical arrangements | Fluid and continually negotiated socio-technical arrangements | What 'common' properties should various collaborative technologies have to enable effective collaboration between different disciplines? |
| Flexibility or closure | Closure and minimum flexibility in local contexts | How can organization achieve flexibility in use and closure in compliancy with internal and external regulations? |
| Top-down or bottom-up | Top-down initiative imposing rigid data classification standards | How, when and to what extent should bottom-up or top-down approaches be employed when implementing large-scale information systems? |
| Heterogeneity or homogeneity | Heterogeneous and discipline-specific technologies | Can working and effective large-scale CIS be achieved with homogeneous technologies? |

**Table 1: Summary of findings**

### 5.1. Common space or spaces?

According to OGC's strategy the company wishes to implement a single, common collaboration tool, namely a system based on Microsoft SharePoint technologies. They have developed 'Best practice' directives and guidelines for the use of this new system seeking to create a consistent usage of the tool throughout the organization. We can look at the use of Microsoft SharePoint as a collaborative tool from two different angles; either it is believed that the entire OGC organization with all employees, tools and equipment is one huge common information space that everyone is a part of, or that OGC consists of a vast number of smaller common information spaces that all have the new CSCW tool in common. Consequently, we ask if it is possible to establish one centralized and tightly integrated large-scale CIS in global organization.

Suggesting that OGC consists of one single CIS is problematic as it to some extend would imply that all employees have significant aspects of their work in common. In a large, heterogeneous organization like OGC this is at best doubtful. Exactly how much does a geologist's work have in common with the work of a production engineer? Or what does the IT department have in common with Human Resources?

As this seems difficult it is more reasonable to assume that OGC consists of a vast number of different common information spaces. That is, for instance, production engineers have one view of the work situation while geologists have a completely different view. The common information spaces at OGC, we suggest, are in many ways similar to the situation in an airport, as described by Fields, Amaldi et al. [6, p.21]. They found that they could "regard the airport not as a CIS but a constellation of overlapping interdependent CISs that are articulated through boundary objects" [6, p.21].

### 5.2. Objects or socio-technical arrangements?

Common information spaces can be seen from two different perspectives: Either 1) as a boundary object; or 2) as a socio-technical arrangement. Boundary objects are "entities that are interpreted differently in different communities of practice, yet are stable enough to retain their integrity as objects, thus facilitating working across the boundaries between different communities" [6]. That is, boundary objects are both flexible enough to allow local interpretations, as well as rigid enough to be similarly enough understood in different communities of practice. This way boundary objects can mediate between different communities. From the socio-technical perspective, a "CIS is not simply a boundary object for different communities of practice, but a socio-technical arrangement that only temporarily on specific occasions are practiced in such ways that give a momentary common understanding" [20, p.494]. This latter perspective, Rolland, Hepsø et al. [20] argue, is particularly relevant when introducing CIS across heterogeneous contexts, where "sharing and negotiating common understanding are much more temporary and fluid than the term boundary object suggests" [20].

In our context, the Microsoft SharePoint technology in OGC can be considered a boundary object, where all users have a similar understanding of what this new tool is, even though they do very different work and uses very different terminology in conducting their daily work. Using the technology, on the other side, can be seen as a socio-technical arrangement where different users interpret and use the technology in different ways in different situations. For instance, a user can utilize the same technology in different ways in different projects or at different times. As a result, we inquire what 'common' properties various collaborative technologies should have to enable effective collaboration between different disciplines.

### 5.3. Flexibility or closure?

As mentioned, Bannon and Bødker [1] explore the dialectic nature of openness and closure within CIS. The openness refers to the flexibility and malleability of CIS and indicates the desire for flexible and malleable information systems. Of course most users would prefer such a system when producing information as they would not have to make specific adjustments like special formatting or meta-tagging to upload their information into the system. The system would be able to handle anything.

The old Lotus Notes-based system appears to have had a large degree of this freedom. After all, by the end the system consisted of about 5000 different databases. If a given piece of information did not fit into the existing databases one would simply create a new database fitting ones requirements.

But to the management of OGC this solution is not satisfactory. It is inefficient; both with regard to workers having to do the same work again as they cannot find documentation of others having already done it, and with regard to storage utilization as the same information is stored more than once.

In the new Microsoft SharePoint based infrastructure users would have a more rigid solution. Information would have to be assigned meta-tags and keywords before they could be uploaded. The benefits of this are not necessarily obvious to the average user, and there is the risk that users simply add more or less meaningless meta-tags and keywords.

As mentioned in a previous section, the use of metadata was the cause of problems and frustration among users. The main problem, according to one of our interviewees (a leading engineer), occurred when establishing new Team Sites. It was very difficult to select an appropriate set of metadata up-front, that is, it is difficult to select the appropriate metadata values before one knows what kind of information that will actually be stored in the Team Site. The metadata selected when creating the Team Site were the metadata members of the Team Site would have to choose from when uploading information. Another part of the problem was that no two people would ever select the same set of metadata if they where to create the same Team Site. The available set of metadata would therefore be dependent on who created the Team Site. As human beings are inconsistent creatures, the same person would also probably select one set of metadata one day and a completely different set the next day. According to our informants, users of SharePoint feel that these problems manifest themselves in the daily use of the technology, which caused a source to compare using SharePoint and Team Sites with "conducting an extreme sport".

Another problem with the use of metadata is that the various members of the Team Site have to classify their documents when uploading them. One source commented that they were engineers, and that people study library science for several years to learn to classify information. This is an area that further research will investigate more thoroughly.

Balancing the organization's need for standardized and strict solutions against the users' wish for flexible and open tools we believe is an important area of research that we wish to look deeper into. Accordingly, we ask how to achieve flexibility in use and closure in compliancy with internal and external regulations.

### 5.4. Top-down or bottom-up?

There is a long tradition to promote participatory design as a way to reduce the design-use gap [23]. This approach represents so-called bottom-up patterns and requires active users' involvement in various development and maintenance activities. While the benefits of such methods are widely recognized, we wonder how effectively it functions in large-scale projects. For instance, in a recent contribution Ellingsen and Monteiro [6] illustrate how the ambition of seamless integration unfolds over the time. The authors present integration activities in a large-scale health care context and illustrate how ordering activities in one context produce disorder in other contexts. Consequently, they question the appropriateness of participatory design in large-scale contexts: "…truly user-led development is impossible to achieve in large-scale integration projects. Furthermore, this increases the possibilities for unintended consequences and disorders…" [6]. This conceptualization underscores that unintended consequences are inherent, and participatory design techniques will hardly eliminate them. The question then remains to what extent participatory design should be cultivated.

Considering implementation and use of collaborative technologies in OGC, we identify a similar tension as well. For instance, with the previous collaborative infrastructure (Lotus Notes) local actors had the ability to participate in the constitution and maintenance of their local information spaces. However, the new collaborative infrastructure based on MS SharePoint technologies imposes quite rigid information classification standards, which reduces the local actors' ability to modify local spaces according to their needs. Such change illustrates movement from active participation to compliance. Being aware that truly user-led development and maintenance activities in such scale (over 25.000 actors) are hardly possible, we wonder how to balance the local needs with company-wide standards.

In OGC, the implementation of MS SharePoint has not given the users any opportunity to participate in the development process. It was in large a managerial decision to replace the old infrastructure with a new one. With regards to user participation, it was the definition of the metadata set that involved users, that is a few persons in managerial position within the various disciplines and departments in the organization. The average user has had no way to influence the implemented system.

We do as of now not have any data that suggests that the lack of user involvement during implementation is the cause of the problems OGC has had with metadata and classification, but nevertheless, they do have a problem with these issues. When questioned about what it would take to make the users satisfied with the system, one of our informants (a manager within the IT department) simply answered: "I don't think it's realistic to make the users satisfied". He then stressed that he to some extend said this to provoke, but that there were an element of truth in what he said. This illustrates the difficulties of catering to such a large group of users: No matter what you do, you can't make everybody happy! Therefore, we ask how, when and to what extent bottom-up or top-down approaches should be employed when implementing large-scale information systems.

### 5.5. Heterogeneity or homogeneity?

In theory, the constitution of CIS is quite explicit and clear, it encapsulates both actor-networks [9] and human enacted structures [21]. An interesting and more attention gaining aspect of CIS is heterogeneity. We conceptualize our research context as extremely heterogeneous [20], but for analytical purposes, we do not discuss the whole context as such, we zoom-in and unpack only a technological actor – collaborative technologies – MS SharePoint and Lotus Notes at OGC.

Both technologies are to some extent homogeneous. They cut across organizational boundaries and impose particular patterns of use. However, MS SharePoint technologies, as outlined above, are more rigid. Additionally, it is an integrative technology, which seamlessly integrates with other Microsoft products. Thus, MS SharePoint can be conceptualized as a large-scale homogeneous and integrated monolithic structure, while Lotus Notes is more flexible and customizable to local needs.

Drawing on a recent conceptualization on CIS [20] in heterogeneous contexts, we inquire whether working and effective CIS can be achieved with homogeneous technologies. As illustrated by Rolland et al. [20] arrangements of heterogeneous technologies tend to be more effectively exploited in cross-discipline collaborative environments.

## 6. Conclusions and furhter research directions

Our research findings suggest that integration is an inherently complex process involving continuous negotiations between various human and non-human actors. Both technical [29] and socio-technical [4] studies report that integration efforts tend to drift from the initial plans and produce various side effects. Drawing on an interpretive field study in OGC we have identified the uncertain and drifting nature of CIS as well. In our case, ambitions to establish an 'out of the box', centralized and tightly integrated collaborative infrastructure produced side-effects and invoked the development of custom components, which aim to increase flexibility for the end user. As recently outlined by Ellingsen and Monteiro [6], ordering in one context tend to produce disorder in other contexts. This aspect can also be supported with the recent conceptualizations that actions are continually other-taken [9]. Such conceptualization emphasizes uncertainty and dynamics of use when technologies are put to use. Ambitions to eliminate particular tensions (as discussed in section 5) are rather subjective, because it is difficult or perhaps hardly possible at all to test or evaluate how a particular configuration will function later on.

Our ongoing research suggest that large-scale CIS is composed of smaller overlapping common information spaces containing heterogeneous collection of socio-technical arrangements that need to be continually (re)negotiated by the actors involved. These findings challenge the assumption that large-scale centralized and tightly integrated, rather than distributed and fragmented, CIS can be achieved in large-scale contexts.

Considering that this paper reports early research findings our further research activities will explore the questions identified in the discussion section, aiming to get in-depth knowledge on implementation and use of collaborative technologies in OGC.

## 7. Ackowledgements

This research was in part supported by the AKSIO project financed by the Norwegian Research Council (PETROMAKS, pr.nr. 163365/S30). We would like to thank several of our colleagues at NTNU for their comments and suggestions, as well as acknowledge the contribution of the anonymous reviewers at HICSS-41.

## 8. References

1. Bannon, L. and Bødker, S. Constructing Common Information Spaces. in Hughes, J.A., Prinz, W., Rodden, T. and Schmidt, K. eds. *ECSCW '97. Proceedings of the Fifth European Conference on Computer-Supported Cooperative Work, September 1997, Lancaster, UK*, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1997, 81-96.
2. Bossen, C. The parameters of common information spaces:: the heterogeneity of cooperative work at a hospital ward *Proceedings of the 2002 ACM conference on Computer supported cooperative work*, ACM Press, New Orleans, Louisiana, USA, 2002.
3. Ciborra, C. Interpreting e-government and development: Efficiency, transparency or governance at a distance? *Information Technology & People*, *18* (3). 260.
4. Ciborra, C.U. *The labyrinths of information : challenging the wisdom of systems*. Oxford University Press, Oxford, 2002.
5. Ellingsen, G. and Monteiro, E. A Patchwork Planet: Integration and Cooperation in Hospitals. *Computer Supported Cooperative Work*, *12*. 71-95.
6. Fields, B., Amaldi, P. and Tassi, A. Representing collaborative work: the airport as common information space *Technical Report*, Middlesex University, School of Computing Science, 2003.
7. Klein, H.K. and Myers, M.D. A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly*, *23* (1). 67.
8. Kuldeep, K. and Jos van, H. Enterprise resource planning: introduction. *Commun. ACM*, *43* (4). 22-26.
9. Latour, B. *Reassembling the social an introduction to actor-network-theory*. Oxford University Press, Oxford, 2005.
10. Lave, J. and Wenger, E. *Situated learning legitimate peripheral participation*. Cambridge University Press, Cambridge, 1991.
11. Linthicum, D.S. *Next generation application integration : from simple information to Web services*. Addison-Wesley, Boston, Mass., 2004.
12. Monteiro, E. and Hepsø, V. Infrastructure Strategy Formation: Seize the Day at Statoil. in Ciborra, C.U., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E. and Simon, K.A. ed. *From control to drift: the dynamics of coporate information infrastructures*, Oxford University Press, Oxford, 2000, 148-172.
13. Monteiro, E. and Hepsø, V. Purity and Danger of an Information Infrastructure. *Systemic Practice and Action Research*, *15* (2). 145-167.
14. Nordheim, S. and Päivärinta, T. Implementing enterprise content management: from evolution through strategy to contradictions out-of-the-box. *European Journal of Information Systems*, *15* (6). 648.
15. Orlikowski, W.J. CASE tools as organizational change: Investigating incremental and radical changes in systems development. *MIS Quarterly*, *17* (3). 309.
16. Orlikowski, W.J. Improvising Organizational Transformation Over Time: A Situated Change Perspective. *Information Systems Research*, *7* (1). 63.
17. Orlikowski, W.J. Material knowing: the scaffolding of human knowledgeability. *European Journal of Information Systems*, *15* (5). 460.
18. Randall, S. What's Common about Common Information Spaces?. *Workshop on Cooperative Organisation of Common Information Spaces*, Technical University of Denmark, 2000.
19. Robey, D. and Boudreau, M.-C. Accounting for the Contradictory Organizational Consequences of Information Technology: Theoretical Directions and Methodological Implications. *Information Systems Research*, *10* (2). 167185.
20. Rolland, K.H., Hepsø, V. and Monteiro, E., Conceptualizing common information spaces across heterogeneous contexts: mutable mobiles and side-effects of integration. in *ACM conference on Computer supported cooperative work*, (Banff, Canada, 2006), ACM Press, 493 - 500
21. Rolland, K.H. and Monteiro, E. The Dynamics of Integrated Information Systems Implementation: Multiplication of Unintended Consiquences.
22. Schmidt, K. and Bannon, L. Taking CSCW Seriously: Supporting Articulation Work *CSCW: An International Journal*, *1(1-2)*. 7-40.
23. Schuler, D. and Namioka, A. *Participatory design principles and practices*. L. Erlbaum Associates, Hillsdale, N.J., 1993.
24. Schultze, U. A Confessional Account of an Ethnography about Knowledge Work. *MIS Quarterly*, *24* (1). 3,39.
25. Suchman, L.A. *Plans and situated actions : the problem of human-machine communication*. Cambridge University Press, Cambridge, 1987.
26. Walsham, G. Interpretive case studies in IS research: Nature and method. *European Journal of Information Systems*, *4* (2). 74

# Paper two

Jarulaitis, G., & Monteiro, E. (2009). *Cross-contextual use of integrated information systems*. Paper presented at the 17th European Conference on Information Systems, Verona, Italy.

**17th European Conference on Information Systems**

# CROSS-CONTEXTUAL USE OF INTEGRATED INFORMATION SYSTEMS

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## Abstract

*Large-scale organizations are increasingly promoting more collaborative and collective work practices across organizational boarders. A predominant way to achieve better collaboration in large-scale heterogeneous contexts is to establish an integrated and standardized technological infrastructure. Ethnographically inspired studies, on the other hand, have challenged such perspective and illustrated that generic technology does not fit in local contexts and needs to be worked-around. Similarly, this paper empirically exemplifies local workarounds and illustrates ongoing and persistently imperfect integration of a collaborative infrastructure in a global oil and gas company. More importantly, however, our analysis focuses on how integrated technology is used across contexts. We illustrate how local workarounds, as a result of tight technological integration, shape use patterns across contexts. Integrated systems establish interdependencies across contexts, thus, the use implies cross-contextual rather than local enactment. Since the trajectory of enactment is influenced by cross-contextual constrains, our study is addressing the existing overemphasis on studying/analysing the use of technology in isolated local contexts. Practically, our study suggests considering workarounds as an intrinsic part of every day work, which should be calculated as additional costs of making the generic technology to work in practice.*

*Keywords: workarounds, integrated systems, situated action, standardisation*

# 1 INTRODUCTION

Abandoning earlier and overly structuralist accounts, there has been a steady increase in information systems research exploring contextual aspects of how technology is developed and used (Avgerou and Ciborra 2004). Ethnographically inspired studies have demonstrated beyond any reasonable doubt the situated nature of how information systems are appropriated (Orlikowski 1996; Robey and Sahay 1996; Walsham 2001). Theoretically, there has been an 'agentic turn', which has "led increasingly to the theoretical positions that privilege human agency over social structures and technological futures" (Boudreau and Robey 2005, p.3), for instance by advocating how technology is always 'enacted' (Orlikowski 2000). The locus of attention is local work practices and how technology is enacted in a situated context, where context is limited to individual actor's engagement and "recurrent interaction with the technology at hand" (Orlikowski 2000, p. 47). Since, enactments more than often deviate from intended system design, a practical concern, then, relates to whether workarounds need to be eliminated (Azad and King 2008) or considered as an intrinsic part of every day work (Rolland and Monteiro 2002).

Integrated, collaborative systems (e.g. enterprise resource planning (ERP) systems, coordination technology (Lotus Notes, MS SharePoint), customer relationship management (CRM) systems) are attractive to business and public sector for their promise to promote more collaborative and collective work practices. Working more collectively across geographical, professional and organizational boundaries entails that one previously local, independent context of use gets linked with (i.e. becomes dependent on) other contexts. As opposed to largely local, independent contexts of enacted technology, use of integrated systems implies the *interdependent* enactment *across* the contexts now linked as a result of the *integration*.

The main purpose of this paper is to analyse the form and implications of cross-contextual enactment of integrated systems. We explore questions such as: how does one local workaround affect other contexts of use; how does local appropriation of technology 'travel' to other contexts mediated by the integration, possibly creating unintended consequences there?

The empirical basis of our paper is an ongoing, longitudinal (2007-2008) case study of a global oil and gas company (OGC, a pseudonym to maintain anonymity) where we also earlier (1997-1998) studied integrated, collaborative systems (Monteiro and Hepsø 2002). Operating across significant geographical, professional, business and organizational boundaries, OGC is struggling to move towards more collaborative modes of working. Integrated systems are a strategically recognised vehicle to address this challenge. Our study reports from an ongoing effort to deploy an integrated system based on Microsoft SharePoint (MSP) technologies[1]. We trace out local enactment (e.g. workarounds) of MSP, but more importantly demonstrate the cross-contextual nature of this enactment i.e. how workarounds in one context affect local appropriation of MSP in another context.

The structure of the remainder of this paper is organized as follows. In the next section we conceptualize the use of integrated information systems. Then, we outline our research approach and introduce historical context and intentions of changing collaborative infrastructure in OGC. Thereafter, we illustrate and discuss how local workarounds, as a result of the tight integration in MSP, shape use patterns across contexts. Finally, we provide analytical implications for studying the use of integrated IS and offer practical implications for managing generic infrastructures.

[1] http://www.microsoft.com/SharePoint/default.mspx

# 2 CONCEPTUALISING THE USE OF INTEGRATED SYSTEMS

## 2.1 Using technology in a situated context

Mirroring a more general interest in the social sciences for practice theory (Gherardi 2000; Savigny, Knorr-Cetina et al. 2001), information systems research has for some years studied its principal 'practice' viz. the practices that go into the use of information systems. Analyses of how users perceive, appropriate and subsequently use information systems demonstrate the highly contextual or situated nature of the use (or practice of use, if you want) of technology.

An early and influential contribution was Gasser's (1986) study of users' strategies of fitting, augmenting and working around the intentions inscribed into the functionality of the system. Gasser (ibid.) empirically illustrated what people actually do when confronted with rigid and unreliable computing procedures. The author vividly illustrated that users in fact do not use information systems as they are designed, but invent various ad-hoc strategies to fit the technology for a particular task. The major conceptualization from this study was the notion of *workaround*, which refers to "using computing in ways for which it was not designed or avoiding its use and relying on an alternative means of accomplishing work" (ibid., p.216).

While Gasser (1986) studied the rigid inventory control system, other more flexible types of systems were studied as well. For instance Orlikowski (1996) investigated how quite small customer support department used a new system to provide a better service for customers. Orlikowski (ibid.) illustrated how users contingently appropriate technology over the time. The central characteristic of appropriation is continuous change with unpredictable trajectory ('improvisation') rather than stability.

Central to these studies is to understand how technology is used in a situated context. While the notion of context is certainly vague (Chalmers 2004), context, in this case, is limited to individual actor's engagement and "recurrent interaction with the technology at hand" (Orlikowski 2000, p. 47).

## 2.2 Integrated systems

Several scholars have been interested in how integrated systems are used ('enacted'). For instance, Boudreau et al. (2005) in their recent study showed how, despite inherent rigidity of an ERP system, users are working-around the system in unintended ways. They argue that users first avoid the system (due to inertia), later learn by improvising (rather than in formal training) and finally reinvent the system in not-planned ways. Thus, the authors emphasize the human agency perspective over the technological logic and argue that "technology's consequences for organizations are enacted in use rather than embedded in technical features" (ibid. p.14). Other researchers have similarly emphasized the impossibility of large-scale systems to be universal across contexts due to local relevance or cultural fit (Joshi, Barrett et al. 2007). Some researchers have suggested that workaround is an intrinsic part of every day work rather than negative or unwanted effect (Rolland and Monteiro 2002).

In general, it was suggested that technologies would always drift from initial plans due to the improvisational capability of a human actor. In turn, the same technology can produce contrasting effects in similar organizational contexts (Robey and Sahay 1996) and these should be addressed employing the logic of opposition (Robey and Boudreau 1999).

Overall, studies on IS use tend to overemphasize local practices and do not "adequately address the longer-term co-evolution of artefacts and their social settings of use" (Pollock, Williams et al. 2007, p.257). Certainly, the relationship between contexts and spanning-effects are discussed by several scholars (Hanseth, Ciborra et al. 2001; Ellingsen and Monteiro 2006), however, there are few if any studies which conceptualize how local workaround does influence other contexts of use. For instance Boudreau et al. (2005) do identify the relationship between local appropriations: "An error occurring at one level of the system would have a ripple effect at other levels" (ibid., p.13), however they do not elaborate on the issue, nor do the authors elaborate what is the role of local enactments in larger contexts: "one cannot categorically argue that unintended actions are good, any more than one can argue that they are bad. Like any other aspect of organizational behaviour, evaluations of effectiveness are relative, not absolute" (ibid., p.16).

To sum it up, the study of integrated information systems has been framed to date largely along the lines of practice theory in the sense that local strategies for appropriation and use have been highlighted. Our study supplements this with a more systematic attention to the interdependence of cross-contextual appropriation mediated by integrated systems.

# 3 METHOD

We report from an ongoing longitudinal research project started in January 2007. Our research approach can be conceptualized as an interpretive case study (Walsham 1993) as we "attempt to understand phenomena through the meanings that people assign to them" (Klein and Myers 1999, p.69).

Data collection activities started at the beginning of 2007 with the primary aim to explore the change associated with the implementation of MS SharePoint technologies. We have employed 3 modes of data gathering: informal and formal interviews, observation and document studies.

We have conducted 25 in-depth interviews, on average lasting 1-1.5 hours. First interviews were open ended and aimed to identify IT strategic visions and implementation activities related to MS SharePoint. During later interviews, we analysed specific infrastructural components, work practices or individual engagements with technology. The technological complexity and intentions behind the new infrastructure were discussed with developers, administrators and managers of the collaborative infrastructure. The use of collaborative infrastructure was explored with actors from several organizational units. Interviewed users represent such disciplines as technology managers, human resources, senior researchers and various engineers involved in oil and gas production activities.

Participatory observations and informal discussions were mainly carried out in one of the OGC research centres, where both authors were granted access since the beginning of data collection. Since January 2008, one of the authors has been granted an office space, an access badge and access to OGC IT network. Since then, the researcher has been spending 2-3 working days a week in the research centre. Significant amount of time spent on-site forms the understanding of how work is carried out in practice and what problems and frustrations users experience on a daily basis. Additionally, being on-site gives an opportunity to have informal but informative chats around a coffee machine or during lunch breaks.

The third major empirical data source is internal OGC documents. We have extensively studied strategic documents related to planning and implementation activities of MSP. Additionally, we analysed technical descriptions, formal presentations and training materials on various MSP infrastructural components. A number of policy documents, which define how particular technology should be used or how specific work has to be carried out, were studied in detail. Finally, OGC intranet portal provided extensive contextual information on diverse OGC activities.

Data analysis is ongoing and iterative. Considering changing researchers involvement and overlapping but not the same research focus, the analysis of empirical data has many trajectories. This difference gives us a unique opportunity to analyse implementation process from slightly different perspectives. It is quite often that after interviews, if conducted together, we have a discussion and analyse what new aspects we have uncovered or what needs more attention in the subsequent data collection steps. In our faculty, there are several actors (not only the authors of this paper) exploring MSP implementation activities in OGC. We meet and discuss quite often either around a coffee machine or having more formal discussion sessions. Considering that the authors of the paper are involved researchers, significant part of data analysis and validation is actually occurring with the help of OGC actors. During informal or formal meetings, we frequently present our findings to various OGC actors. In turn, we are challenged, supported or directed to the issues that need more attention. For instance, several record's information managers supported our early findings on the metadata use in research and development activities, but we received extensive comments and suggestions to collect more empirical data in operative environments. Adjustments to some generalizations were made and empirical data collection directions were embraced.

In general, empirical data is classified in broad themes reflecting specific organizational project, practice or technical component. Such classification is neither all encompassing nor exhaustive; it is rather overlapping and continually changing. Theory has an important role in the analysis process. It provides an analytical lens to sort out and reclassify empirical data. For instance, in relation to this paper, the concept of workaround implied to determine when is a workaround (in relation to formal policy) and classify empirical data according to why, where and how workarounds are practiced. The concept of 'generification' implied to analyse how local workarounds 'travel' across contexts and what effects they produce.

# 4 CASE: COLLABORATION AND INTEGRATION

## 4.1 Context and history

Established only in the 1970s, the global oil and gas company (OGC, a pseudonym) has grown from a small, regional operator in Northern Europe to a significant energy company, currently employing some 30.000 people with activities in about 40 countries across 4 continents. OGC has grown largely organically, but with selected, important national and international acquisitions. Facing limited growth potential in its region of origin, OGC is actively pursuing a strategy to grow globally. To boost its financial capacity and flexibility, in the 1990s OGC diversified and expanded its shareholder ownership including getting listed at the New York Stock Exchange.

Alongside its growth in size, geography and business areas, OGC has been engaged in a number of corporate-wide initiatives to improve communication and collaboration. These initiatives have relied heavily on information systems. The first comprehensive effort to establish a corporate, collaborative information systems infrastructure was in the early 1990s (Monteiro and Hepsø 2002), at a time of oil industry recession, falling oil prices and dollar rates. Centralization, standardization and market orientation of IT services was the direct outcome of several projects whose primary aim was to solve the problems of fragmented and incompatible IT solutions. The outcome of standardization activities led to the establishment of the Lotus Notes-based collaborative infrastructure.

The Lotus Notes based infrastructure has proven successful inasmuch as it has been widely used for a range of different purposes. A key vehicle for facilitating collaboration within projects in OGC has been Lotus Notes Arena (Arena for short) databases for collective storing and dissemination of documents. The challenge, however, with the Lotus Notes based infrastructure has been to promote communication *across* the project-defined boundaries of the Arena databases. The Arena databases had no central indexing functionality, meaning that it was impossible to retrieve a document by searching if one did not know which database to search. With Arena databases thriving apparently 'out of control' – there were some 5000 databases by the latest estimates – locating relevant information stored outside your immediate project scope was non-trivial. Each user had in addition access to both personal (G disc) and departmental storage (F disc) areas. In short, information was scattered and duplicated over many local storage arenas.

### 4.2 New collaborative strategy – higher efficiency with tighter integration

To overcome the problems with Lotus Notes and establish more effective ways of collaboration, coordination and experience transfer, OGC formulated a new strategy in 2001. According to this strategy, OGC already had a set of general collaboration tools, but "these tools are poorly integrated", and "there is a particular need for better and more integrated coordination tools, better search functionality and improved possibilities for sharing information with external partners" (internal strategy documents). The change in the collaborative infrastructure was defined as a necessity and catalyst in order to achieve goals formulated in the strategy. The decision was made in 2003 and the rollout of a new infrastructure based on the Microsoft SharePoint (MSP) started. MSP was selected exactly for its potential to overcome the fragmentation resulting from project-specific Arena databases. Recent accounting regulation in the aftermath of Enron added pressure to ensure more systematic and consistent documentation of business decisions to inform the stock market and the public.

MSP is a core element in the new OGC collaborative infrastructure. The central element of MSP is so-called team site (TS), the virtual arena for collaboration. TS provides functionality to check-in and check-out documents, post announcements, share links and create discussion boards. Another important element of TS is a so-called workspace. A workspace is a web site connected to a TS (sometimes called baby-team site), used for production and sharing of a specific document or collection of documents. While MSP is mainly used for documents management, the technology is integrated with a corporate-wide search engine, an archive system and MS Exchange system.

While the technology itself (MSP) is customizable for specific contexts, the OGC decided to make the solution as generic as possible so that it would fit all contexts (internally it is referred as one-size-fits-all strategy). The strategic choice to rollout 'out-of-the-box' solution with minimum customization was highly influenced by the previous implementation experiences. In particular, the straightforward MSP implementation process was planned in contrast to recent experiences with an opposite (extensive customization) strategy when implementing a several hundred million dollars worth corporate-wide ERP solution. These experiences were translated in the standardization of both the functionality and the interface of every TS. The only element that differentiates team sites is metadata. The metadata standard provides a common and standardized classification scheme on how the information should be classified. Thus, the metadata can be seen as the main element in the collaborative infrastructure, which should fit a generic TS to a specific local situation. The metadata standard represents quite complex classification scheme with 13 different 'elements' and corresponding 'sub-elements'. In total there are more than 120 sub-elements in the metadata standard. Taking into account all sub-elements, the standard describes "identity, authenticity, content, structure context and essential management requirements of information objects" (OGC internal).

## 5 ANALYSIS: CONTEXTUAL AND CROSS-CONTEXTUAL USE

What studies of contextual use of information systems have convincingly established is the importance, indeed, necessity, of users' active appropriation of technology to local circumstances and concerns. In other words, local workarounds (or appropriation, tweaking, improvisation, drift etc.) are not anomalies or design shortcomings but *constitutive* elements of working technologies (Rolland and Monteiro 2002).

Zooming in on two extended illustrations from OGC's implementation of MSP (the use of workspaces and classification of documents), we first reiterate this point. More importantly, however, we go on to identify how these local workarounds – as a result of the tight integration in MSP – shape use patterns in other contexts of use. Table 1 summarizes this. One way, then, to formulate the gist of our analysis is to say that the local strategies of appropriation, the prerequisite of working information systems, are simultaneously non-local side-effects significantly influencing patterns of use in other contexts (i.e. cross-contextual).

| | **Local context: appropriation** | **Cross-contextual: side-effects** |
|---|---|---|
| The use of workspaces | Reproducing folder structure from entrenched practices | Invisibility of information due to the incorrect information and access rights management |
| Classification of documents | Overriding default values to fit local context<br><br>Incorrect, but convenient classification of sensitive information | Undermining the search engine and distributing additional work<br><br>Availability of sensitive information and suspension of the search engine for 5 months |

*Table 1. A summary of local (contextual) and non-local (cross-contextual) enactments of integrated information for two examples within the MSP infrastructure.*

### 5.1 Workspaces: local appropriation as replicating existing practices

Prior to the implementation of MS SharePoint an important decision not to have folder structure in team sites was made. This decision was made due to the technical inability to create a complex folder structure in team sites (limitations of the URL length). On the other hand, users in OGC had quite long experience with folder structure in Lotus Notes infrastructure and indeed as Boudreau et al. (2005) explain did have difficulties to 'forget' previous practices. In the initial stages of MS SharePoint implementation users tended to avoid the new system and used file servers to share information instead. As one manager explained, the amount of documents in file servers exploded when team sites were introduced. However, after some time users got acknowledged with the system and found out that it is possible to replicate previously existed folder structure with the help of workspaces:

> "From the beginning it was very clearly communicated that we are not allowed to use workspaces to replicate folder structure. That was the intention… however people have been using computers here for the last 15 years, so they actually continue to make folders with workspaces despite the fact that they are told no to do so… All our team sites have a pile of workspaces [the user navigates to one of the team sites and shows a list of approximately 30 workspaces]" (User working with operational support for offshore activities)

Overall, replicating folder structure with workspaces is quite popular workaround in OGC. In particular, the workaround is practiced in information-rich contexts. The 'popularity' of this workaround illustrates that users do not adhere to OGC policies but are actively engaging and experimenting with technology. The existence of such workaround is not surprising; it can be explained with the concept of 'installed base', used by Boudreau and Robey (2005). Such treatment of workaround requires shifting the focus from identification to explanation of the effects a workaround is producing. Precisely because the MSP infrastructure is integrated, local appropriations, outlined above, are not only local; they have cross-contextual implications.

The initial intention of using workspaces was related to the possibility for team site users to create 'areas' (i.e. workspaces) with custom access rights. In that sense, a workspace was considered as a temporary 'arena' in order to limit or expand the original access rights in a team site. However, in practice, users sometimes create folder-like workspace structures and use the functionality of limiting the access. Importantly, in its current configuration, corporate-wide search engine is only returning those documents that a user has access to. Thus, documents stored in workspaces with limited access rights will be visible and retrievable only to specified users and 'invisible' to others.

Cross-contextual effects are especially experienced by users working across contexts i.e. whose ability to find information depends not only on their skills, but also on how others manage information locally. For instance, a well engineer responsible for conducing well interventions across different fields explains:

> "It is quite often that we do not have access to necessary information. When planning a well intervention we have to know a lot of technical information about a particular well and history of the well in general [this includes information about previous challenges/problems, and conducted interventions with corresponding experience reports produced after each intervention]. Sometimes you do not find information just because you do not have access… so you have to call various people and ask… it is very time consuming and I know some people do not bother spending all their time on that… however, not having important information means more uncertainty during operation, and this can increase the risk and cost of operation." (Well engineer; emphasis added)

Oil and gas exploration, production and export activities span across many disciplines not only in the OGC, but a significant part of activities is carried out by various external contractors. For instance, while a plan to drill a new well is primarily produced by several internal disciplines, an external contractor can perform drilling. This means that for a certain period of time an external contractor needs access to information related to the new drilling activities and probably to some historical reports. It adds complexity to access management, and workarounds made some time ago tend to pop-up here:

> "It is quite often that I get a call asking for help to find information or to give access. So I have to use a lot of my time on this… I would like them [contractors] to be more independent … to avoid this [access problems], for instance, after a meeting with contractors I am sending two emails, one to internal OGC employees with a link to a document and another one to external ones with attachment." (Drilling engineer; emphasis added)

Many users are aware of cross-contextual effects of incorrect access rights management by explaining that they do not know whether a specific information is existing or not: "the worst thing is that if you don't find information it does not necessarily mean that information is non-existing" (Engineer). Such effects lead to uncertainty and distrust the capabilities of the search engine. In general, these examples show that local workarounds change use patterns across contexts. In that sense, working in an 'integrated environment' means shifting the focus from how the system fits locally to how the system fits across contexts.

### 5.2 Classification of documents: the power of the default value

The decision to have flat document structure did not fuel too much enthusiasm for end-users and, as argued in the previous section, invoked workarounds. By removing folder structure the implementation team understood that some alternative way to classify information should be provided. In turn, it was decided to develop a common predefined classification scheme, which would form the basis for information structure and help both to sort and retrieve information.

As we have argued in the previous section that thinking 'flat' (no folders) introduces some problems, common classification scheme also did provide challenges for end users. The notion of 'common' does not imply fits-all or having the same meaning across contexts, on the contrary, as Star (1991, p.44) explains, "no networks are stabilized or standardized for everyone". Thus, in some contexts classification is not acknowledged:

> "this metadata, it is bad… very often when you will store a document none of the provided values fit. For instance for this document I can choose from 10-12 different values… but they all do not fit… for this document I can select such values as 'none', 'agenda', 'minutes', 'presentation'… this document is presentation so 'presentation' value fits very well [the respondent starts laughing]" (Engineer working with oil and gas production; emphasis added)

While users are quite often confronted with metadata that does not fit in their contexts, the questions remain how they cope with this situation. Sometimes users just tend to ignore the existence of metadata and use such values as ‘none’ or ‘miscellaneous’. It was planned to have a controlled vocabulary (the values are predefined in advanced) and all policies state that users should use provided metadata. Interestingly enough, MSP functionality allows to delete provided metadata values and create new ones. In turn, the second enactment strategy is to develop new values that would make more sense in local context:

> “We have replaced provided metadata values with the new ones, which actually represent the activities we are working on in the project. Provided values were meaningless in relation to this project, so it would make no sense to use them” (User working in R&D)

Another challenging issue related to classification in OGC is the classification of sensitive information. Users are provided with rather simple security classification scheme to identify which documents can be available to anyone (open), to all OGC employees (internal), to specific groups (restricted distribution) or to selected individuals (confidential). Security classification is managed in team site and on the workspace level, implying that confidential document should be placed in a confidential team site rather than in an open one. The security classification scheme can be described as simple and intuitive, however, in practice, the definition of what is ‘confidential’ and how it should be handled (for the sake of convenience or additional work) is not given.

In turn, local enactments diverge from formal policies. It was, up to now, quite a ‘standard’ to store personal information on the private team site, which is not classified as confidential. In some instances, due to convenience reasons, a classified report from an external company was stored in an ‘open’ projects team site, rather than in a workspace with restricted access. Perhaps the most ‘problematic’ enactment of security classification was to store, due to unawareness and additional work, human resources related information in not confidential team sites.

Overall, classification, being an inseparable part of everyday work, is not given but has to be enacted in practice (Bowker and Star 1999). The problematic aspect, as we have illustrated above, is that imposed common classification has local variations (workarounds). While the problem of global standardization and local variation has received quite some attention (Star 1991), it is much less clear how local variations ‘travel’ across contexts. Essentially, common (shared and used across contexts) classification can be characterized as inherently having cross-contextual aspects. Such aspects are captured with writing/reading metaphor: “any reading and writing artefact that accumulates inscriptions cannot but coordinate [constrain and transform] the activities which write and which read these inscriptions” (Berg 1999, p.391). Thus, working-around common classification not only erodes the common and controlled character of classification, but also automatically imposes a certain amount of additional work for actors across contexts.

Such cross-contextual effects can be nicely illustrated with an example of planning and drilling a new well. While planning activities are conducted onshore, drilling process is to a large extent managed offshore. Planning is a collective effort of various disciplines and results in producing several documents. Central documents describe the whole drilling program, detailed drilling procedures, possible risks and a checklist, just to mention some. Drilling a new well means producing at least some 200 documents, which have to be stored in team site(s). Since they are stored in a flat structure, metadata is the primary sorting and filtering mechanisms. The problem according to one engineer is that “while the metadata values are not very bad, people sometimes do not use them or use them wrong”. In turn, incorrect use of metadata in one context, produce effects in other contexts:

> “sometimes I get a call in the evening from offshore people saying that they have been searching for a specific document for an hour or so with no success… to avoid this we have developed a practice [which is unofficial i.e. a workaround] that for every new drilling program, a drilling engineer [working onshore] creates an excel document containing links to documents that are most important for drilling engineers working offshore. It is additional work as we [engineers working onshore] have to update those excel documents during

> drilling, but then offshore people have much better overview." (Drilling engineer working onshore; emphasis added).

In that sense local workaround (wrong classification of documents) produce additional work in other contexts and later trigger other workarounds (engineers developing an excel sheet with links). Thus, local workarounds can produce ripple effects. More importantly, achieving working infrastructure entails collective enactment across contexts rather than local enactment.

Another, more substantial cross-contextual effect, was enacted with security classification. Documents were not always classified as intended. Incorrect classification of documents, due to the tight integration with the corporate search engine, made possible for confidential information to be available to many more than it should be. For instance, during an interview with two system administrators responsible for technical aspects of MS SharePoint infrastructure, we were shown the possibilities of the search engine. One administrator entered the name of his colleague sitting besides to demonstrate how the search engine works in practice. Among the first results, a document containing the administrator's work evaluation appeared. It was an embarrassing moment, for administrators in particular. Such document contains personal information, and it should be available only to few persons and certainly should have not been retrieved in that situation. Similar local enactments not only propagated across contexts but accumulated as well. The situation, according to one manager "got out of control, since too much sensitive information due to incorrect classification was available for way too many users". Since it was not impossible to apply any 'quick fix', the search engine was suspended. The corporate-wide search service was not available to users for 5 months, the period that was used to 'clean-up' incorrect classification and develop the approach that would prohibit such incorrect enactments later. Compulsory training sessions, technical usability improvements, control routines and other initiatives are currently executed to prevent such effects. However, as it is now acknowledged in some management levels, order without workarounds is out of reach: "we may hope for altered attitudes and more care taken in the future – however, all the time search has been suspended, people have been working as before (but all the errors have been "invisible" as search was not available)" (a recent presentation on information security in OGC).

# 6 IMPLICATIONS AND CONCLUSIONS

We draw two sets of implications from our study of the deployment of a MS SharePoint based information infrastructure in OGC: one analytic and one practical.

Analytically, our study demonstrates the rich array of strategies and improvisational acts that go into the local appropriation of technology. Existing research (see above) has vividly illustrated process of social shaping of technology, i.e. how both flexible and rigid technologies are shaped in situated contexts. In line with the 'practice perspective' of Orlikowski (2000), our findings confirm that local workarounds, tinkering and 'situated improvisations' are not anomalies or design shortcomings but constitutive elements of working technologies.

More importantly, however, our study continues to address the nature of non-local – what we in this paper have dubbed cross-contextual – effects that are embedded in the appropriation of integrated systems. For sure, the mere existence of cross-contextual effects has been acknowledged before. Boudreau and Robey (2005) for instance point out that local practices may have 'ripple effect' beyond the local context. Yet they fail to develop this observation into a more systematic framework or make it subject to substantial theorising (see Hanseth et al. (2006) for an exception). One implication of our study, then, is to contribute to a higher visibility of cross-contextual effects of the use of integrated information systems. Systematic attention to cross-contextual side-effects extend the way the use of integrated information systems has been conceptualized to date. As opposed to largely local independent contexts of enacted technology, the use of integrated systems implies the interdependent enactment across contexts now linked as a result of integration. This entails considering the technological, and in particular integrative technological, detail more seriously than the previously outlined 'practice lens' (Orlikowski 2000) or the application of the 'practice lens' in integrative environments (Boudreau et al. 2005). In this way, our study is addressing the existing overemphasis on human agency and contributes to the studies on mutual shaping of information technology and its use, to approach equally important question on how technologies constrain the trajectory of enactment (Kallinikos 2004; Doherty, Coombs et al. 2006). The empirical illustration above of how the accumulation of multiple, local appropriations added up to the effect of closing down the corporate-wide search engine service for almost half a year is difficult to arrive at with attention largely focused on local, contextual or situated 'enactment' of technology.

Practical implications of our study relate to the (project) management of embarking on large-scale, comprehensive infrastructure like efforts of the type reported here. At the core, the insight that due to the scale and heterogeneity of work practices and existing technological interdependencies, workarounds need to be considered as constitutive elements of working infrastructures rather than anomalies, design shortcomings or unexpected effects. More importantly, working-around integrated systems cannot be any longer considered as local phenomena, which could be black-boxed and ascribed to a specific context. Prototyping early versions of integrative technology, for instance, has more limited value than for non-integrated technologies. While the attractiveness of integrated technology is based on seamless cross-contextual information exchange, such technological platform also comes (quite often as a surprise) with inherent cross-contextual effects. Simply put integrative technology is more than often evaluated from a perspective of what positive effects it can bring, while underestimating how local (small and perhaps unimportant at first) activities can produce great effects some time later across contexts. Essentially, the benefits of integrated systems can only be realized if they are fitted across contexts rather than in some local contexts.

The second practical implication relates to the evaluation of cost and benefits (Goodhue, Wybo et al. 1992) of generic, corporate-wide integrative infrastructures. We consider the term evaluation from an interpretive perspective (Walsham 1993, p.165-186) rather than an economic one. 'Costs', include both, the developer's effort to establish technological platform and users adjustments of technology to his/her needs. Generic solutions are adjustable and can fit quite well in some, but most often not in all contexts. If generic technology does not fit, additional work ('costs') has to be carried out. Classification is an illustrative example of this. We have exemplified how locally irrelevant classification will require additional users work to make it meaningful locally. The same happens with generic technological functionality. For instance, some users in OGC, unsatisfied with MSP functionality, voluntarily and not in accordance with existing policies, invest their time in implementing, learning and using more flexible technologies (such as Groove) or social software solutions (Wiki's). One way to evaluate then is to consider, by percentage, to how many actors the generic technology does fit. A qualitative alternative is to consider whether generic technology fits well in specific (not excluding core) business activities. In our evaluation, we are employing the latter perspective, and have illustrated throughout the paper that both development and use costs are high, and we doubt whether they outweigh the benefits. As the IS management literature suggests, the implementation of new technology should be cost-efficient. In turn, the management should take into account not only the costs of establishing integrated technical infrastructure, but the invisible (i.e. workarounds) costs as well. In that sense, it should be made explicit who, how much and when will pay the costs of having the generic integrated infrastructure.

## REFERENCES

Avgerou, C. and C. Ciborra (2004). The Social Study of Information and Communication Technology, Oxford University Press

Azad, B. and N. King (2008). "Enacting computer workaround practices within a medication dispensing system." European Journal of Information Systems 17(3): 264.

Berg, M. (1999). "Accumulating and Coordinating: Occasions for Information Technologies in Medical Work." Comput. Supported Coop. Work 8(4): 373-401.

Boudreau, M.-C. and D. Robey (2005). "Enacting Integrated Information Technology: A Human Agency Perspective." Organization Science 16(1): 3.
Bowker, G. C. and S. L. Star (1999). Sorting things out classification and its consequences. Cambridge, Mass., MIT Press.
Chalmers, M. (2004). "A Historical View of Context." Computer Supported Cooperative Work (CSCW) 13(3-4): 223 - 247.
Doherty, N. F., C. R. Coombs and J. Loan-Clarke (2006). "A re-conceptualization of the interpretive flexibility of information technologies: redressing the balance between the social and the technical." European Journal of Information Systems 15(6): 569.
Ellingsen, G. and E. Monteiro (2006). "Seamless Integration: Standardisation across Multiple Local Settings." Computer Supported Cooperative Work V15(5): 443-466.
Gasser, L. (1986). "The Integration of Computing and Routine Work." ACM Transactions on office Information systems.
Gherardi, S. (2000). "Practice-Based Theorizing on Learning and Knowing in Organizations." Organization 7(2): 211-223.
Goodhue, D. L., M. D. Wybo and L. J. Kirsch (1992). "The Impact of Data Integration on the Costs and Benefits of Information Systems." MIS Quarterly 16(3): 293.
Hanseth, O., C. U. Ciborra and K. Braa (2001). "The Control Devolution ERP and the Side-effects of Globalization." The Data base for advances in information systems 32(4): 34-46.
Hanseth, O., E. Jacucci, M. Grisot and M. Aanestad (2006). "Reflexive Standardization: Side Effects and Complexity in Standard Making." MIS Quarterly 30: 563.
Joshi, S., M. Barrett and G. Walsham (2007). "Balancing local knowledge within global organisations through computer-based systems: an activity theory approach." Journal of Global Information Management 15(3): 1-19.
Kallinikos, J. (2004). Farewell to Constructivism: Technology and Context-Embedded Action. The Social study of information and communication technology : innovation, actors, and contexts. F. Land, C. Avgerou and C. U. Ciborra. Oxford, Oxford University Press: 140-161.
Klein, H. K. and M. D. Myers (1999). "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems." MIS Quarterly 23(1): 67.
Monteiro, E. and V. Hepsø (2002). "Purity and Danger of an Information Infrastructure." Systemic Practice and Action Research 15(2): 145-167.
Orlikowski, W. J. (1996). "Improvising Organizational Transformation Over Time: A Situated Change Perspective." Information Systems Research 7(1): 63.
Orlikowski, W. J. (2000). "Using technology and constituting structures: A practice lens for studying technology in organizations." Organization Science 11(4): 404.
Pollock, N., R. Williams and L. D'Adderio (2007). "Global software and its provenance: Generification work in the production of organizational software packages." Social Studies of Science 37(2): 254-280.
Robey, D. and M.-C. Boudreau (1999). "Accounting for the Contradictory Organizational Consequences of Information Technology: Theoretical Directions and Methodological Implications." Information Systems Research 10(2).
Robey, D. and S. Sahay (1996). "Transforming work through information technology: A comparative case study of geographic information systems in county government." ISR 7(1).
Rolland, K. H. and E. Monteiro (2002). "Balancing the local and the global in infrastructural information systems." Information Society 18(2): 87.
Savigny, E. v., K. Knorr-Cetina and T. R. Schatzki (2001). The Practice turn in contemporary theory, Routledge.
Star, S. L. (1991). Power, technologies and the phenomenology of conventions: on being allergic to onions. A Sociology of monsters essays on power, technology and domination. J. Law. London, Routledge: 26-56.
Walsham, G. (1993). Interpreting information systems in organizations. Chichester, Wiley.
Walsham, G. (2001). Making a world of difference: IT in a global context. Chichester, Wiley.

# Paper three

Jarulaitis, G. (2010). *The Uneven Diffusion of Collaborative Technology in a Large Organisation*. Paper presented at the IFIP WG 8.2 + 8.6 Joint International Working Conference, Perth, Australia.

Is not included due to copyright

# Paper four

Jarulaitis, G., & Monteiro, E. (2010). *Unity in Multiplicity: Towards Working Enterprise Systems*. Paper presented at the 18th European Conference on Information Systems Pretoria, South Africa.

# UNITY IN MULTIPLICITY: TOWARDS WORKING ENTERPRISE SYSTEMS

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## Abstract

*Enterprise systems are attractive exactly as they promise a stronger unity – integration, collaboration and standardization – across distinct and different organisational units of a business. However, empirical research on enterprise systems has documented convincingly how situated workarounds undermine the unity of enterprise systems through local thus different practices and adoptions. This produces an apparently paradoxical character of enterprise systems: unity in the face of multiplicity. Our contribution is (i) to outline a theoretical middle-position effectively resolving the paradox and (ii) identify and analyse empirical strategies for how the paradox gets resolved in practice. The empirical basis for our study is a longitudinal (2007-2009) case study of a global oil and gas company with 30.000 employees operating in 40 countries across 4 continents.*

*Keywords: Enterprise systems, Enactment, Fragmentation of information, Integration*

# 1 INTRODUCTION

Large organisations comprise a number of different functional areas including development, manufacturing, sales and marketing involving a significant number of professional/ disciplinary groups or communities that tend to be dispersed geographically. The functional, professional and geographical boundaries within an organization often translate into corresponding boundaries between supporting information systems. This, Davenport (1998) describes, is the background for the fragmented character of the collection of information systems found in business organisations, a fragmentation that enterprise systems are intended to eliminate.

Despite the seductive promises of enterprise systems, empirical research has demonstrated the non-universal character of enterprise systems (Soh, Kien et al. 2000) and the need to either configure technology (Fleck 1994; Markus, Tanis et al. 2000) or change work practices (Davenport 1998; Robey, Ross et al. 2002). But if, as practice-based research seems to suggest (Orlikowski 2000), the enactment of enterprise systems varies with situations and users, has all aspiration of unity then evaporated?

Drawing on actor-network theory (ANT) based insights, we discuss conceptualisations of material artefacts embedding degrees of multiplicity (Mol 2003; Law and Singleton 2005). From such a perspective, a given enterprise system is viewed as consisting of multiple modules, functionalities and practices, thus not a unified whole. Yet, unity is temporally established *when needed* through socio-technical strategies; unity is an ad-hoc, triggered and performed achievement.

The oil and gas company (OGC, a pseudonym to maintain anonymity) we study struggle to impose stronger unity and tighter integration between its many units. Our longitudinal (2007-2009) case study reports from an ongoing effort to deploy an integrated system based on Microsoft SharePoint (MSP) technologies. The motivation from OGC management for implementing MSP was similar to enterprise systems "to ensure information integrity by having one primary source… to ensure business continuity… to improve integrated work processes and increase our work efficiency." (OGC internal documents). Adding to the pressure, OGC grappled with how to enforce Sarbanes-Oxley[1] (SOX) compliant routines to satisfy the post-Enron requirements on increased documentation, transparency and accountability of business related work practices and decisions applicable to all companies listed at the New York Stock Exchange.

The structure of the remainder of this paper is organized as follows. In the next section we present current perspectives on enterprise systems. Then, we outline our research approach and introduce historical context and intentions for implementing MS SharePoint. We then analyse the different strategies that users employ in order to achieve unity. Finally, we provide analytical implications for studying the use of integrated systems and offer practical implications for managing enterprise systems.

# 2 PERSPECTIVES ON ENTERPRISE SYSTEMS

As Davenport (1998) explains enterprise systems are designed to solve the problem of fragmentation of information across multiple systems. Managing multiple information systems "represent one of the heaviest drags on business productivity and performance" (ibid., p.123) and enterprise systems with a single repository promise seamless integration of all the information through a company. Integrating data into a single repository entails standardization of data and processes across organizational

[1] Being listed on the New York Stock Exchange, OGC must comply with U.S. laws and regulations. The Sarbanes-Oxley act (SOX) of 2002 is a United States federal law enacted on July, 30, 2002, as a reaction to a number of major corporate and accounting scandals. The primary intention of SOX is to ensure the accuracy and transparency of financial statements.

contexts (Volkoff, Strong et al. 2005). In that sense, enterprise systems impose centralization and control over information (Davenport 1998).

Empirically, especially practice-based, research on enterprise systems challenges the ambition of unity. These studies spell out the situated character of local enactment of enterprise systems (Boudreau and Robey 2005; Chu and Robey 2008). Soh, Kien et al. (2000) show how inscribed intentions originating from a western context fail to fit in a public organisation in south-east Asia. Wagner and Newell (2004, p.325) studied ERP implementation in a university and concluded that “in a context where you have diverse user groups, with different work practices and epistemic cultures (Knorr-Cetina, 1999), and with different levels of background experience, a single industry solution is not going to be ‘best’ from all perspectives”.

If, as practice-based research argues, “every encounter with technology is temporally and contextually provisional, and thus there is, in every use, always the possibility of a different structure being enacted” (Orlikowski 2000, p.412), what they accounts for the unity? Quattrone and Hopper (2006) dubs this the paradox of ‘heteromogeneous’: enterprise systems are on the one hand a singular artefact but simultaneously enacted in indefinitely many different ways: “If enactment yields diversity, what brings stability?” (ibid., p. 242).

Lee and Myers (2004, p.927) suggest that “enterprise integration is perhaps best described as a cycle: as a cycle of integration, disintegration, and reintegration”. Similarly Hanseth et al. (2006) vividly illustrated how standardization does not follow linear pattern. Standardization according to Hanseth et al. (2006) is reflexive implying that efforts to standardize produce unintended side-effects, which again invoke efforts of standardization.

All packaged enterprise software is similar as it is “ready–made mass product offering users a solution based on design processes aimed at generic customer groups in a variety of industries and geographical areas” (Van Fenema, Koppius et al. 2007, p.584). ERP studies currently dominate in IS literature, leaving other enterprise systems such as Customer Relationship Management (CRM) or groupware less explored. Microsoft Sharepoint (MSP) thus represents a class of information systems with different functions than traditional enterprise systems (lacking for instance order entry, inventory and accounts) but with a comparable ambition to unite a functionally, geographically and disciplinary fragmented organisation, given that MSP always get integrated with additional modules to supplement its functionality. This aspect of MSP corresponds to that of information infrastructures.

Studies on information infrastructures shift the focus from single to multiple systems and emphasize the need to cultivate legacy systems rather than eliminate them: “the impossibility of developing an information infrastructure monolithically forces a more patch-like and dynamic approach. In terms of actual design, this entails decomposition and modularization” (Hanseth 2000, p.70). In that sense, fragmentation of information across multiple systems is not a negative aspect, but rather a precondition for an information infrastructure to scale across different settings.

Generalising the notion of a boundary object, Bowker and Star (1999, p.314) develop a concept of boundary infrastructure in order to emphasize “the differing constitution of information objects within the diverse communities of practice that share a given infrastructure”. This accounts for diverse communities engaged in different practices which still are recognised to belong to the ‘same’. Mol (2003, p.6) states that “no object, no body, no disease, is singular. If it is not removed from the practices that sustain it, reality is multiple”. The relevance of Mol’s concept is that it, in contrast to boundary object/ infrastructure, starts from the premise that different communities operate largely independent of each other. Only occasionally and on an ad-hoc basis is unity produced. An artefact, Mol (ibid., p. 55) explains, “is not fragmented. Even if it is multiple, it hangs together”. The question to be asked, then, is how this is achieved. “It is not a question of looking from different perspectives either as differences are incompatible; there is not one object but multiple; objects are multiple and “make a patchwork” (ibid., p. 72). Yet, and this is for us the relevant aspect of Mol’s analysis, when required in given circumstances, unity in the sense of compatibility is produced as a practical task. Unity is rare and only achieved on demand and temporarily.

# 3 METHOD

We report from an ongoing longitudinal research project started in January 2007. Our research approach can be conceptualized as an interpretive case study (Walsham 2006) as we "attempt to understand phenomena through the meanings that people assign to them" (Klein and Myers 1999, p.69).

Data collection activities started at the beginning of 2007 with the primary aim to explore changes associated with the implementation of MS SharePoint technologies. Study is multi-contextual in nature, aiming to analyze how collaborative technologies are used across different contexts. We have employed 3 modes of data gathering: formal and informal interviews, observation and document studies.

We have conducted 64 in-depth formal interviews, lasting from 1 to 3 hours. First interviews were open ended and aimed to identify IT strategic visions and implementation activities related to MS SharePoint. During later interviews, we analyzed specific infrastructural components, work practices or individual engagements with technology. The technological complexity and intentions behind the MS SharePoint were discussed with developers, administrators and managers of the collaborative infrastructure. We have conducted 14 formal interviews with actors from this group. The use of collaborative infrastructure was explored with actors from several organizational units. 23 formal interviews were conducted in the R&D context with various engineers and senior researchers. 27 interviews were conducted in the contexts of oil and gas production activities, where we interviewed drilling, well, production and process engineers.

Participatory observations and informal discussions were mainly carried out in one of the OGC research centres, where both authors were granted access since the beginning of data collection. Since January 2008. Since January 2008, one of the authors author has been granted an office space, an access badge and access to OGC IT network. Since then, the researcher has been spending 2-3 working days a week in the research centre. Significant amount of time spent on-site forms the understanding of how work is carried out in practice and what problems and frustrations users experience on a daily basis. Additionally, being on-site gives an opportunity to have informal but informative chats around a coffee machine or during lunch breaks.

The third major empirical data source is internal OGC documents. We have extensively studied strategic documents related to planning and implementation activities of MSP. Additionally, we analyzed technical descriptions, formal presentations and training materials on various infrastructural components. A number of policy documents, which define how particular technology should be used or how specific work has to be carried out, were studied in detail. Finally, OGC intranet portal provided extensive contextual information on diverse OGC activities.

Data analysis is ongoing and iterative. In our faculty, there are several actors (not only the author of this paper) exploring how collaborative technologies are used in OGC. We meet and discuss quite often either around a coffee machine or having more formal discussion sessions. Significant part of data analysis and validation is actually occurring with the help of OGC actors. During informal or formal meetings, we frequently present our findings to various OGC actors (both managers and various users). In turn, we are challenged, supported or directed to the issues that need more attention. In general, empirical data is classified in broad themes reflecting specific organizational project, practice or technical component. Such classification is neither all encompassing nor exhaustive; it is rather overlapping and continually changing. Theory has important role in the analysis process. It provides an analytical lens to sort out and reclassify empirical data. For instance, in relation to this paper, we draw on the concept of multiple objects (Mol 2003; Law and Singleton 2005). It implied to conceptualize a single enterprise systems as being multiple and focus on how unity is achieved in practice.

# 4 CASE: COLLABORATION AND INTEGRATION

## 4.1 Ongoing Efforts to Standardize and Centralize Collaborative Infrastructure

Established only in the 1970s, the global oil and gas company (OGC, a pseudonym) has grown from a small, regional operator in Northern Europe to a significant energy company, currently employing some 30.000 people with activities in 40 countries across 4 continents. OGC has grown largely organically, but with selected, important national and international acquisitions. Facing limited growth potential in its region of origin, OGC is actively pursuing a strategy to grow globally. To boost its financial capacity and flexibility, in the 1990s OGC diversified and expanded its shareholder ownership including getting listed at the New York Stock Exchange.

Alongside its growth in size, geography and business areas, OGC has been engaged in a number of corporate-wide initiatives to improve communication and collaboration. These initiatives have relied heavily on information systems. The first comprehensive effort to establish a corporate, collaborative information systems infrastructure was in the early 1990s, at a time of oil industry recession, falling oil prices and dollar rates. Centralization, standardization and market orientation of IT services was the direct outcome of several projects whose primary aim was to solve the problems of fragmented and incompatible IT solutions.

The outcome of standardization activities led to the establishment of the Lotus Notes-based collaborative infrastructure. Diffusion of Lotus Notes started back in 1992 and was considered a key technology for facilitating collaboration within projects. The core element has been Lotus Notes Arena (Arena for short) databases for collective storing and dissemination of documents. Arena was a successful tool for supporting collaboration within teams; however, the challenge has been to promote communication across the project-defined boundaries (across teams) of the Arena databases. The Arena databases had no central indexing functionality, meaning that it was impossible to retrieve a document if one did not know which database to search. With Arena databases thriving apparently ‘out of control’ – there were some 5000 databases by the latest estimates – locating relevant information stored outside your immediate project scope was non-trivial. Each user had in addition access to both personal (G disc) and departmental storage (F disc) areas (i.e. file servers). In short, information was scattered and duplicated over many local storage arenas.

To overcome the problems with Lotus Notes and establish more effective ways of collaboration, coordination and experience transfer, OGC formulated a new strategy in 2001. According to this strategy, OGC already had a set of general collaboration tools, but “these tools are poorly integrated”, and “there is a particular need for better and more integrated coordination tools, better search functionality and improved possibilities for sharing information with external partners” (internal strategy documents). The change in the collaborative infrastructure was defined as a necessity and catalyst in order to achieve goals formulated in the strategy. The selection of the technology that would support the new collaborative strategy followed a long process. A feasibility study was carried out in late 2002. In December 2003, a contract with a vendor was signed and at the beginning of 2004, the first pilot using an MSP out-of-the-box solution was launched. Early experiences of this technology evoked multiple user requests for improvements. In addition, numerous technical components had to be developed in order to achieve better integration between MSP and the existing installed base systems. The beginning of 2005 saw the release of version 1.1. The “role-out” process was fairly fast, and by the end of October 2005 the final 5000 users had been added. Figure 1 illustrates the main events in the development and diffusion of enterprise systems.

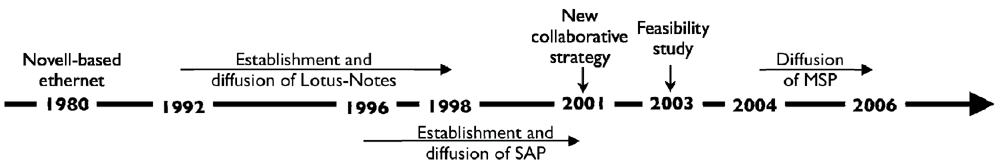



*Figure 1. Timeline illustrating the implementation of enterprise systems OGC*

MSP is a packaged enterprise software (Van Fenema, Koppius et al. 2007) aimed to establish a common collaborative technology for all OGC users. The central element of MSP is so-called team site (TS), the virtual arena for collaboration. TS provides functionality to check-in and check-out documents, post announcements, share links and create discussion boards. MSP is part of overall collaborative infrastructure and is integrated with corporate-wide search engine, MS Exchange system and records management solution Meridio. MSP is configured so that is would be compliant with internal information life-cycle management policies and external laws and regulations.

### 4.2 Divergent Work Practices and Overall Inconsistency

Collaborative technologies are not single-user applications and their primary function is to improve collaboration between and within groups. It is assumed that certain level of standardization is required in order to achieve better collaboration within and across groups. In other words, well or drilling engineers' work practices should be similar regardless of their geographical location. OGC official policies define work processes and specify how particular tools have to be used. In the following examples we illustrate divergent work practices and overall inconsistency.

Despite official policies, information can be managed differently across platforms:

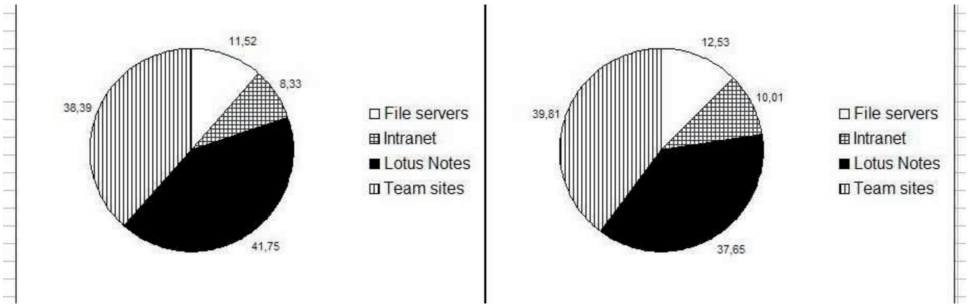
> "we know that another field [oil and gas field] create TSs for disciplines, but we have TSs for business processes… I think it is more correct to do in our way… we are primarily working with one platform and have a dedicated team site for that, but there are two other platforms in this field. Sometimes we have common projects/activities, but there is no team site for such activities… we agreed that common information will stored in platforms' [name of a platform] team site. (Engineer working with maintenance activities)

In addition to intentional deviation from official policies, it is always difficult to specify 100% correct classification schemes, which opens possibility for mistakes:

> "Every platform has one team site for technical information [intended for engineers that maintain platform's equipment] and another one for operational support [for planning and administration activities]. But people tend to mix these. In reality these two activities are connected and sometimes it is difficult to decide where a document should be stored… and sometimes people store documents in a wrong team site…" (Manager working in operational support onshore)

Legacy collaborative systems (Lotus Notes and file servers) set another challenge for achieving overall consistency. OGC makes significant effort to phase out Lotus Notes and reduce the use of file servers, however these systems still used. Despite the fact that all OGC users started to use MSP back in 2005, the legacy collaborative systems still accumulate majority of document (see Figure 2).

Volume by Source Type (%) 18.05.2008 Volume by Source Type (%) 19.04.2009




Total indexed documents: 17.699.536 Total indexed documents: 19.776.065

*Figure 2. Distribution of documents by source in May 2008 and April 2009*

Not all formats, nor all file sizes are supported by MSP, thus file servers is an immediate alternative:

> "We use TS very little, we are mainly working with specialized systems and most of our files [primarily large or MSP unsupported files] are in stored in file servers. Information here [file servers] is classified according to departments, but we do not have those departments any longer… and still those folders are used today" (Engineer).

Some old projects have not yet migrated to MSP:

> "this project [the project aiming to improve recovery from one of the oldest OGC fields] did not migrate to team sites at all. When it started, there was Lotus Notes and they agreed that the project will end in 2009 then in 2010 or 2011… but they still actively use Lotus Notes" (person involved in operational support activities; emphasis added).

An interesting fact is that all OGC users started to use MSP back in 2005 and now it is only minority that is using Lotus Notes. Migration or phasing-out an old system, then, is not about gaining a critical mass of users, but rather considering what is the core and what is periphery. In the case of Lotus Notes (and file servers as well), it is primarily information related to the core OGC activities (i.e. oil and gas production) that is not migrated and as a consequence, Lotus Notes, as well as file servers, cannot be 'phased out', but run in parallel:

> "that's how [referring to file servers] we were working onshore before we got Lotus Notes. It was so much information in use that we were not able to quit with it and fully migrate to LN. So this [file servers] lived further with LN. Later we got TS… and then file servers and LN lived further because it was impossible to migrate with all the historical data we needed. When you need it [the historical system(s)] you can always add some new information to it… [smiling]. So now you have file servers, Lotus Notes and MSP… when something new comes [after MSP], we will probably still keep those three old ones" [smiling] (manager responsible for operational support; emphasis added).

## 5 ANALYSIS: STRATEGIES FOR UNITY

Drawing on Mol (2003) enterprise systems can be conceptualized as being multiple rather than united. The key question of this section, then, is how unity is achieved in practice. Our analysis focuses on the *well*. The well is a crucial object around which principal business related decisions and practices in oil and gas production evolve. How the identify and relevant aspects of a given well is produced is accordingly of vital importance to OGC. Multiple disciplines are involved are involved in well planning, drilling and production optimization activities. OGC drilled the first wells in the early 70ies and information was stored in archives in a paper-based form. Over the time OGC acquired multiple information systems both for legal purposes (i.e. in order to be compliant with national and international legislations) and in order to increase operational efficiency.

In this section we identify three strategies how unity is achieved in practice: (1) navigating in a socio-technical network; (2) s0triving for overviews; (3) patching together a trajectory.

The list of strategies is not exhaustive, yet we identify those strategies as being most important for our respondents. We delineate the strategies for analytical purposes, on a daily work the strategies might overlap.

## 5.1 Navigating in a Socio-Technical Network

In addition to collaborative infrastructure, oil and gas activities are supported by other multiple specialized systems. Figure 3 (each 'box' corresponds to a system) illustrates several systems used by well engineers. Figure 3 presents primarily 'specialized' systems and is a snapshot of the whole drawing, which was done on a A2 sheet of paper.

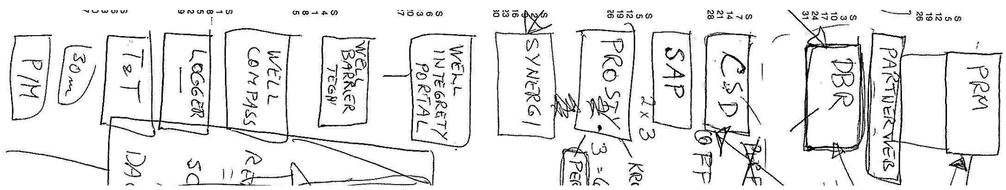



*Figure 3. Fragmentation of well information across multiple systems*

An important aspect is that collaborative systems (i.e. MSP, Lotus Notes or file servers) accumulate only a fraction of total information about a well. It requires laborious work in order to achieve unity from multiple information systems. Engineers (or users in general) have to navigate in a socio-technical network in order to achieve unity. We define navigation as users engagement with technology or social network. For instance, to illustrate how CSD (one of the systems in Figure XX) is used in practice, the respondent had to find an email (in Outlook), which specified recent changes in the system on how to perform search. After spending several minutes searching for a specific document, the respondent walked out of the meeting room and approached a colleague to get some assistance.

How to navigate requires training and experience. For instance, in TS, users have to use sorting and filtering functionalities in order to sort out large-amount of information. Drilling engineer, who recently started to work as well engineer explains:

> "Here [well engineers] people use [i.e. sort information] wellbore [well's name] extensively in order to find specific information. But I have been previously using filtering functionality, because we [drilling engineers] were working with the same well for quite long period… perhaps 8-9 moths. So during that period we were working in the same team site, but here [well engineers] you use many different team sites." (well engineer)

Not all users are capable to find information on their own. Some users did not pass training, others are not eager to learn functionalities that technology offers. In addition, it happens that information is classified wrong or stored in a wrong place. As result, engagement with technology is not necessarily is successful and requires navigation in a social network.

A drilling engineer explains how to navigation in a team site needs to be substituted with help from colleagues:

> "Over the time it becomes difficult to have overview… especially with oldest documents [which are by default in the end of the list]. There are 160 documents now [in a team site library] and this well is only halfway finished. In addition, you have documents in workspaces [user shows number of workspaces on the screen]. Sometimes documents are duplicated [in team site library and workspaces], but sometimes you find them only in one place. It would be possible to have everything in one place, but people do not want to miss overview over documents e.g. related to Recommendation to Drill) process so they create a workspace. So if you have used particular TS a lot you can find information, because you know what to look for… but very often you have to go and ask people where things are stored…" (Drilling engineer; emphasis added)

### 5.2 Striving for Overviews

Another strategy on how to achieve unity is to develop an index. An index is essentially a document containing links to specific documents, information systems or other indexes. Indexes (in OGC called 'portals') are created with MS Word, Excel, Power Point or MindMap[2] software and should be distinguished from bolt-ons (Pollock and Williams 2009, p.42) which do change the functionality of software. Indexes are primarily developed in rather small professional or co-located communities.

How and where a well will be drilled is planned by several professional disciplines onshore, yet drilling engineers working offshore have responsibility to manage drilling activities. In other words offshore drilling engineers are involved in planning activities to a little extent. As result, during drilling it requires active coordination between offshore and onshore engineers:

> "Sometimes I get a call in the evening from offshore people saying that they have been searching for a specific document for an hour or so with no success… to avoid this we have developed a practice that for every new drilling program, a drilling engineer [working onshore] creates an excel document containing links to documents that are the most important ones for drilling engineers working offshore. It is additional work as we [engineers working onshore] have to update those excel documents during drilling, but then offshore people have much better overview." (Drilling engineer working onshore).

There are no official practices for the development of indexes, as result their purpose and scope varies across organization. Figure 4 illustrates index made by drilling engineers. The index is 5 slide PowerPoint presentation, where each slide contains a number of links (Figure 4 illustrates on of the slides). The index is actively used during well planning as it contains links to various document templates (official OGC templates) that have to be completed the process of planning a well. Figure 5 illustrates another index, which is quite general and aimed to provide an overview to the most important information related to drilling, well and production optimization activities. The index is made with MS Excel and saved as a web page in one of the TSs. Differently from the previous index, this one is much broader in scope. The Excel document has thirteen sheets, and each of them contain links to specific documents, templates, various information systems, team sites and other information sources. The index is made and currently managed by a secretary.

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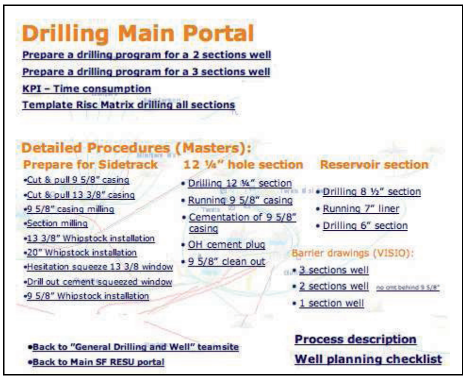
[2] http://en.wikipedia.org/wiki/List_of_mind_mapping_software



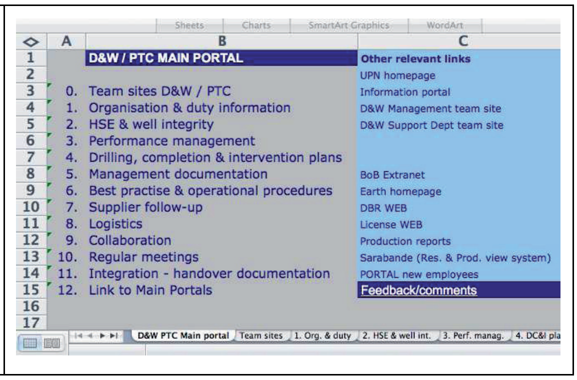




*Figure 4. Index for well planning*

*Figure 5. Index for well and production activities*

Not all indexes are static, some require continuous updating. For instance links to duty lists are updated every 60 days. When a new drilling plan is made a new link has to be added in a specific index. Since development of indexes is not official practice, the ones who make them also pay the cost of keeping them up-to-date. Broken or not updated links are unavoidable given such voluntary activity. Indeed, during several interviews the author of the paper observed how respondents encountered broken links. In such cases, respondents employed navigation strategies (see previous section) and either switched to specific information space or loudly explained which person could help to find specific information.

### 5.3 Patching Together a Trajectory

The oil and gas value chain spans such activities as exploration, well drilling and the optimisation of production. Geophysicists, petrophysicists, and drilling and reservoir engineers are all involved in the planning of new wells. While the drilling is primarily managed by drilling engineers, production engineers observe well performance and initiate well interventions during production, which are then performed by well engineers. These activities are interdependent and distributed in time and space as the different disciplines work with the same well over a period of many years. Above outlined disciplines work with the same well over the time, yet each discipline is working with certain aspects of a well, rather than the whole well. Well is multiple (Mol 2003) as each discipline has specific representations of a well and none of the disciplines have a complete overview of a well.

A core contribution of Mol's (2003) analysis is a vivid illustration of how different disciplines can treat a specific disease of a patent, yet work to a large extent independently and collaborate on ad-hoc basis. Well intervention in oil and gas industry is a good example of such coordination.

The most important characteristics for production engineer is well's performance in terms of oil and gas flows and pressures measured in the bottom and top of a well. Production engineers have a dynamic image of a well as they aim to understand well's performance over the time. When well's equipment fails or wears out, oil and gas production decreases and well intervention needs to be performed. Production engineers initiate well interventions, which range from small (i.e. change of certain equipment) to large (i.e. recompletion of a well). However, production engineers do not know the detailed well's technical information nor do they know exactly how an intervention has to be conducted. Production engineers formalize the need for intervention and initiate collaboration with well engineers.

In order to decide how the intervention will be carried out well engineers have to perform a historical reconstruction of a well. In other words, well engineers in collaboration with other disciplines have to find, analyze and synthesize the multiple objects produced some time ago. As Ellingsen and Monteiro

(2003) argue it requires validation, double-checking and sense-making in order to make various representations credible and trustworthy. Such work is central for well engineers:

> All of us should be aware that information in [name of the system] is not always correct. Preferably, it should be double-checked and compared with other sources for instance [name of the system]. For example information about equipment can be slightly wrong… for instance wrong diameter… it is critical for us to have correct information as we will have to put equipment in the well. (well engineer)

The above quote illustrates how well engineers need to triangulate different information sources in order find correct information. In addition, some information sources are trusted more than others. Which information to trust is not automatic and requires experience. More importantly, it is crucial to acquire the most accurate information otherwise the equipment can be too large in relation to well's diameter and stuck in a well.

During the planning of well intervention well engineers and production engineers (who initiated the intervention) have sequence of meetings in order to discuss how (i.e. the method) intervention will be performed, what equipment will be used, and the risks involved. Complete certainty cannot be produced during the planning process, yet striving for maximum security is crucial. Some interventions deviate (in terms of method) from OGC policies and in such cases well planning leader would initiate additional quality ensuring processes (called peer-review) and invite various engineers (from various OGC departments) to discuss the feasibility of particular intervention and the risks involved:

> "We have a requirement that two barriers have to be established during well intervention [if situation becomes uncontrollable the barriers are closed to prevent oil and gas flows]. Sometimes only one barrier can be established [due to technological constrains] and in this case intervention is not standard [deviates from OGC requirements]. In such case we need professional discussion and initiate peer review process." (well planning leader).

# 6 IMPLICATIONS AND DISCUSSION

The case for unity i.e. the need for tight coordination, integration and standardisation may well have been overstated. Our case strongly suggests that lack of unity is not necessarily a big problem for the users. On the contrary, they display varied socio-techical strategies *on demand*. Through strategies of navigation, indexing and patching up a trajectory, relevant aspects of the well is united for a given purpose at hand. The different communities of users do not make the investment necessary to maintain the degree of coherence and unity laid out for instance within a boundary object/ infrastructure perspective, but postpone until required to patch it up.

Analytically, we draw on Mol (2003) and illustrate how on object (i.e. a well or an enterprise system) can be conceptualized as being multiple rather than single and how different disciplines working around a given object collaborate only when it is needed not continually. We have illustrated how well engineers have to collaborate with production engineers and historically reconstruct the well only when an intervention will be performed. In that sense there is a trigger (for instance the need to change specific equipment in the well) that invokes the need for collaboration and it is only during the intervention period that unity needs to be achieved. If an object (a well or an enterprise system) is multiple and different disciplines are collaborating on ad-hoc basis it does not imply chaos. On the contrary, as Mol (2003, p.55) suggests "the body multiple is not fragmented. Even if it is multiple, it also hangs together".

Our empirical material illustrates that people do indeed work differently, however, we agree with Quattrone and Hopper (2006, p.216): "if there are as many technologies-in-practice as people enacting the structures then the 'structure' concept's heuristic value is questionable". Variation is limited and there are reasons for variation as well. The reasons relate to how often and how intensively different disciplines do collaborate. More importantly, however, our analysis illustrates that users employ multiple strategies to effectively resolve differences. In that sense our findings slightly contradict with an assumption that enterprise systems have to provide a perfect fit.

Recent literature on integration emphasized that standardization activities are not linear, but unfold in multiple cycles: "reflexive standardization, then, shows that when we try to achieve order and closeness we get chaos, openness, and instability." (Hanseth, Jacucci et al. 2006, p.567). Similarly, Lee and Myers (2004, p.927) suggested that enterprise integration "is perhaps best described as a cycle; as one or more cycles of integration, disintegration, and (perhaps) reintegration". Our analysis yields rather a different pattern. Unity in our case does not unfold as cycle, but is established temporally when needed through socio-technical strategies; unity is an ad-hoc, triggered and performed achievement. We identify two patterns on how unity is achieved: (1) unity is rare, but requires intense collaboration and significant effort from the involved actors; (2) unity is achieved often, and collaborative effort is continuous, but less intense. Regarding the first pattern, we illustrated how well interventions are initiated and planned (see section 5.3). The need for collaboration can be triggered by the need to change specific equipment in the well. Production engineers (who initiate the intervention) collaborate with well engineers (who plan and perform the intervention) only during the period when intervention is planned and performed. Such type of collaboration is intense and requires sequence of formal meetings as well as less-formal conversations. The second pattern is observed in contexts were certain disciplines work on a specific project (or object) over a long period of time. Analytically, this pattern is closer to the notion of boundary objects, yet similarly as the first pattern is triggered by a certain issue/problem. For instance, drilling engineers working offshore are not involved in well planning activities and do not know where certain documents are stored. As result, drilling engineers working onshore create indexes so that drilling engineers working offshore would find documents easier (see section 5.2 for more details).

# 7 CONCLUSIONS

Variation in local practices, workarounds should not be taken as undermining the purpose of enterprise systems per se. Mismatches, glitches, incompatibilities are sorted out when required – and quite effectively so. From a practical point of view this implies that enterprise systems are not an issue of for/ against unity, but at what cost should unity be achieved. Where effective strategies for patching up unity are in place and/or the frequency when this happens is relatively low, it makes better (cost-effective!) sense to not invest resources to establish higher degrees of unity on a more permanent basis; the overheads are too grim.

One the other hand, if unity needs to be achieved quite frequently, it is wise to establish more stable objects. For instance, our analysis of the strategy 'striving for overviews' (see section 5.2) suggests that development of indexes in certain areas of OGC could be declared as best practice rather than overlooked invisible work.

Our findings show how through strategies for patching up unity enterprise systems become working enterprise systems. Given the configurational possibilities (i.e. development or extension of specific modules for specific business areas) of enterprise systems and the various users' strategies for achieving unity (few of them we have illustrated in section 5), our study goes beyond dichotomy of local vs global and illustrates how enterprise systems become working systems. Our study is based on implementation of enterprise systems for 30.000 users, yet given that our analysis focuses on micro-practices, we assume that similar strategies for patching up unity would be required in smaller contexts as well.

## References

Boudreau, M.-C. and Robey, D. (2005). Enacting Integrated Information Technology: A Human Agency Perspective Organization Science. 16 (1), 3.

Bowker, G. C. and Star, S. L. (1999). Sorting things out classification and its consequences, Cambridge, Mass., MIT Press.
Chu, T. and Robey, D. (2008). Explaining changes in learning and work practice following the adoption of online learning: a human agency perspective European Journal of Information Systems. 17 (1).
Davenport, T. H. (1998). Putting the enterprise into the enterprise system Harvard Business Review. 76 (4), 121.
Ellingsen, G. and Monteiro, E. (2003). Mechanisms for producing a working knowledge: Enacting, orchestrating and organizing Information and Organization. 13 (3), 203-229.
Fleck, J. (1994). Learning by trying: The implementation of configurational technology Research Policy. 23 (6), 637.
Hanseth, O. (2000). The Economics of Standards. From control to drift: the dynamics of coporate information infrastructures. C. U. Ciborra, et. al. Oxford, Oxford University Press**:** 56-71.
Hanseth, O., Jacucci, E., Grisot, M. and Aanestad, M. (2006). Reflexive Standardization: Side Effects and Complexity in Standard Making MIS Quarterly. 30, 563.
Law, J. and Singleton, V. (2005). Object Lessons Organization. 12 (3), 331.
Lee, J. C. and Myers, M. D. (2004). The Challenges of Enterprise Integration: Cycles of Integration and Disintegration over Time. Proceedings of International Conference on Information Systems.
Markus, M. L., Tanis, C. and Fenema, P. C. v. (2000). Multisite ERP implementations Association for Computing Machinery. Communications of the ACM. 43 (4), 42.
Mol, A. (2003). The body multiple : ontology in medical practice, Durham, Duke University Press.
Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations Organization Science. 11 (4), 404.
Pollock, N. and Williams, R. (2009). Software and Organizations. The biography of the enterprise-wide system or how SAP conquered the world, Routledge.
Quattrone, P. and Hopper, T. (2006). What is IT?: SAP, accounting, and visibility in a multinational organisation Information and Organization. 16 (3), 212-250.
Robey, D., Ross, J. W. and Boudreau, M.-C. (2002). Learning to Implement Enterprise Systems: An Exploratory Study of the Dialectics of Change Journal of Management Information Systems. 19 (1), 17-46.
Soh, C., Kien, S. S. and Tay-Yap, J. (2000). Cultural fits and misfits: Is ERP a universal solution? Association for Computing Machinery. Communications of the ACM. 43 (4), 47.
Van Fenema, P., Koppius, O. and Van Baalen, P. (2007). Implementing packaged enterprise software in multi-site firms: intensification of organizing and learning European Journal of Information Systems. 16 (5).
Volkoff, O., Strong, D. M. and Elmes, M. B. (2005). Understanding enterprise systems-enabled integration European Journal of Information Systems. 14 (2), 110.
Wagner, E. L. and Newell, S. (2004). 'Best' for whom?: the tension between 'best practice' ERP packages and diverse epistemic cultures in a university context The Journal of Strategic Information Systems. 13 (4), 305-328.
Walsham, G. (2006). Doing interpretive research. European Journal of Information Systems. 15 (3), 320.

# Paper five

Jarulaitis, G., & Hepsø, V. (2010). Cross-contextual work practice: Investigating strategies for navigating across islands of knowledge. Submitted to the *Information and Organization* journal.

# Cross-Contextual Work Practice: Investigating Strategies for Navigating Across Islands of Knowledge

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**Abstract**

In contrast to existing conceptualisations that work practise is a particularly situated affair, the paper empirically demonstrates how despite contextual differences similar work is performed across multiple contexts. Drawing on a longitudinal case study from a Oil and Gas Company (OGC) we illustrate how the emergence of subsea technologies invoke a change in well maintenance activities. While previously the same engineers maintained a set of wells over a certain period of time, currently a group of engineers perform well maintenance activities across numerous oil and gas fields. The paper analyses what differences engineers experience and what strategies they employ in order to sort-out differences and perform well maintenance activities in a cost-effective and safe manner. Our findings contribute to practice theories and recent discussions on non-local aspects of work.

Keywords: Situated action, Standardisation, Boundary work, Knowing in practice

# 1 Introduction

The tension between standardisation and situated work has been a central concern within information systems (IS) research over the past two decades. The standardisation of work within a specific function or process is essential to modern large-scale organising. It is inspired by and draws upon the successful establishment of large-scale bureaucratic organising in the early 19th century and the more recent "reengineering movement". Standardisation builds on three premises. First, that the same or very similar work should be carried out in a similar manner and produce similar results, regardless of geographical location or who is performing the tasks. Second, standardisation prevents "reinventing the wheel" and improves the use of organisational resources. Third, "if you get the engineering right, the human factor will fall into place" (Morgan, 2006, p.22). As such, standardisation can be understood as a mode of organising work within large-scale organisations.

Standardisation seeks to reduce organisational diversity. Yet, for nearly three decades, empirical research on organisations has advocated the need for organisational diversity within large-scale organisations. This builds upon the premise that human action is not predetermined by formalised descriptions, but only influenced to a varying extent (Suchman, 2007). Rather than relying upon standardised universal knowledge, work practices are shown to embody knowledge that is "localized, embedded, and invested in practice" (Carlile, 2002, p.442). Similarly, technology requires "interpretive flexibility", meaning that "for different social groups, the artefact presents itself as essentially different artefacts" (Bijker, 1992, p.76).

Within the context of IS research, empirically-oriented studies emphasise human agency as well. In-depth accounts have vividly illustrated how technologies are not used as intended, but instead are worked-around (Gasser, 1986). Moreover, scholars have empirically illustrated that the same activities are performed differently across geographical and organisational boundaries. For instance, Soh, Kien et al. (2000) proposed a notion of misfit to confront the logic of standardisation against organisational diversity. The authors have identified three types of misfits, namely, data, functional and output, and argued that inscribed intentions originating from a western context fail to fit into a public organisation in Southeast Asia.

Yet, studies emphasising the situatedness and contingencies of work rarely address how work can be both situated and standardised. In-detail descriptions of local contexts and confrontations with formal descriptions allowed the rejecting of deterministic accounts, and yet another extreme position was established. To this end, the following question is posed: If work practice is bound to local contingencies, how can the same work be carried out across different contexts?

More recent studies on enterprise systems indentified the gap in the above outlined studies and emphasised the mediating role of technology across multiple organisational contexts (Boudreau & Robey, 2005; Rolland & Monteiro, 2002). Few empirical studies have demonstrated how enterprise systems establish links between previously independent contexts (Vaast & Walsham, 2009), thereby allowing for more distributed work practices (Pollock, Williams, D'Adderio, & Grimm, 2009).

Our study is inspired by these recent accounts, yet our empirical and analytical basis is different. Our analytical lens is inspired by the writings of Turnbull (2000) and Carlile (2002; 2004). According to Turnbull (ibid.), there are multiple social and technical strategies for "enabling local knowledge/practices to move and to be assembled" (Turnbull, 2000, p. 41). In what follows, the main contribution of this paper is an empirical and analytical discussion of how similar work is carried out across different contexts.

We have deliberately chosen to study practice, which is cross-contextual in itself. The empirical basis for our study is a longitudinal (2007-2010) case study of collaborative work practices in an oil and gas company (OGC, a pseudonym used to maintain anonymity). We have studied multiple organisational contexts, although the context presented in this paper was specifically chosen to explore the cross-contextual aspects of work. Traditionally, the same group of people maintained wells in an oil and gas field over a long period of time. In line with the aforementioned literature, maintenance work relied on situated work practices. Recently, however, due to current organisational and technological changes, a new organisational unit, called

Light Well Interventions (LWI) was established with the primary aim of performing well maintenance activities at numerous oil and gas fields. As a result, well maintenance relies on practice, which is capable of getting close enough to "local" and performing well maintenance activities in a cost-effective and safe manner. The primary aim of the paper is to explore how the same work (i.e. well maintenance) is performed across numerous contexts (i.e. oil and gas fields).

The remainder of the paper is organised as follows: Firstly, we present studies on situated work practices and identify gaps in the literature. Next, we outline our research approach and introduce the contexts of our case – oil and gas production. Thirdly, we analyse what challenges actors face when performing the same work across different contexts. Lastly, we discuss analytical and practical implications for work practices that span multiple contexts.

# 2 Theory

## 2.1 Situated work practice

The tension between standardisation and situated work has been a key concern within information systems (IS) research over the past two decades. The successful establishment of assembly lines in manufacturing at the beginning of the 19th century continues to inspire modern organisations on how to achieve economies of scale. In particular, large-scale organisations employ the logic of standardising work across various functions and/or business processes. Such organising is also strengthened with the recent widespread diffusion of enterprise systems.

On the other hand, for nearly three decades empirically-oriented research has advocated a different perspective. Scholars within Science Studies have made a so-called "practice turn" (Savigny, Knorr-Cetina, & Schatzki, 2001) and emphasised the situated nature of work. Suchman (2007) argues that work practice is not predetermined by formal specifications, but instead is contingent and "depends in essential ways on its material and social circumstances" (ibid., p. 70). In turn, intentions to standardise and establish universal work practices across contexts ends up in local variations (Timmermans & Berg, 1997). Similarly, rather than being a stable artefact, technology has been conceptualised as having "interpretive flexibility", implying that "for different social groups, the artefact presents itself as essentially different artefacts" (Bijker, 1992, p.76).

Drawing on Science Studies, IS scholars made an agentic turn and emphasised how the trajectory of information systems depends on local contingencies. For example, Robey and Sahay (1996) conducted a comparative case study of a geographical information system (GIS) implementation within two government organisations and identified "radically different experiences with, and consequences of, the GIS technology" (ibid., 93). While in one organisation technology played an important role in transforming work practices, the second organisation experienced only minor social changes. A widely cited work by Orlikowski (2000, p.412) also suggested that "every encounter with technology is temporally and contextually provisional, and thus there is, in every use, always the possibility of a different structure being enacted". In short, IS scholars have revealed through longitudinal and comparative studies that technology use is bound to local contingencies.

The "practice turn" for organisational scholars also had profound implications. Knowledge has been conceptualised as being "localized, embedded, and invested in practice" (Carlile, 2002, p.442). Given such a conceptualisation, an organisation has been understood as consisting of multiple communities, each having their own "local" (i.e. unique) practice. As a result, communities were separated by multiple boundaries, which function as "fences" and hinder knowledge circulation. Orlikowski (2002) studied global product development in geographically distributed organisations and identified "temporal, geographic, political, cultural, technical, and social boundaries" (ibid., p. 256). While boundaries seem to hinder knowledge flow, it has been argued that boundaries are a prerequisite for perspective making (Boland & Tenkasi, 1995) or innovation more generally (Carlile, 2002).

## 2.2 Re-situating knowledge

Detailed descriptions of local contexts and confrontations with formal descriptions allowed for the rejecting of deterministic accounts, and yet another extreme position was established. In turn, Shapin (1995, p.307) asks a provoking question: "If, as empirical research securely establishes, science is a local product, how does it travel with what seems to be unique efficiency?"

Few social studies have addressed this question. According to Turnbull (2000), a variety of social strategies (e.g. collective work) and technical devices (e.g. theories, books, lists) are essential "for treating instances of knowledge/practice as similar or equivalent and for making connections, that is in enabling local knowledge/practices to move and to be assembled" (ibid., p. 41). In short, work across contexts is not a given but requires action, which is embedded in particular socio-technical conditions.

Likewise, organisation researchers emphasise the need to not only identify boundaries, but to also show the means for how they can be spanned, i.e. be reduced by establishing a common ground (Bechky, 2003). The facilitation of knowledge sharing across boundaries is usually achieved with technological devices (e.g. boundary objects) (Star & Griesemer, 1989), social strategies such as boundary spanning activities (Levina & Vaast, 2005) or a combination of both. According to Orlikowski, the essence (2002, p.256) is "knowing how" to "navigate (i.e. articulate, attend to, engage with) as well as negotiate (i.e. redefine, reconstruct)" boundaries. Carlile (2002, 2004) takes a slightly different path and offers a pragmatic perspective on how and which boundaries need to be spanned in a given situation. Carlile (2004) attempts to demystify boundary work and develops an integrative framework for managing knowledge across boundaries. Accordingly, the challenge of sharing knowledge relates to syntactic, semantic and pragmatic boundaries. In terms of a syntactic boundary, knowledge is transferred by the means of a common lexicon. A semantic boundary relates to interpretive differences across boundaries, whereas a pragmatic boundary recognizes that knowledge is at "stake" and needs to be transformed in order to overcome the boundary.

In what follows, we intend to use Carlile's (2002; 2004) conception of boundary spanning to address collaboration across boundaries. Since we are focusing on IS, we are particularly interested in the ensemble of objects and artefacts light well intervention engineers use to move knowledge across boundaries in order to resolve consequences that arise when different types of knowledge are dependent on each other (Carlile, 2002, p. 443). We employ the following three properties of knowledge at a boundary: difference, dependence and novelty (Carlile, 2004, p. 556-557). First, for our purposes, a complex operational scenario requires differences in the amount and type of knowledge, which ultimately leads to differences in levels of experience, terminologies, tools, and incentives unique to each specialized domain. The second relational property of knowledge at a boundary is dependence. Difference has no consequence without dependence. Two entities must take each other into account if they are to meet their goals while addressing dependence among tasks and resources. The third and final relational property of knowledge at a boundary is how novel the circumstances are. If there is novelty to share with other partners and novelty to assess from others, this becomes problematic. When one or several actors is unfamiliar with the common knowledge being used to represent the differences and dependencies between domain-specific knowledge, a common knowledge to adequately share and assess domain-specific knowledge at a boundary is lacking.

IS researchers have only recently started to conceptualise how integrated technologies influence multiple and previously independent work practices. Vaast and Walsham (2009) studied distributed communities of practice in the field of Environmental Health. The authors emphasised the role of technology, and coined the term "trans-situated learning" to explain how people can communicate and exchange experience with the help of technology, yet do not share an actual context of work (i.e. separated by a geographical boundary). Pollock, Williams et al. (2009) studied how one of the largest packaged software producers in the world provides customer support. In contrast to Orr's (1996) conceptualisation that technical repair is bound to local contingencies, Pollock, Williams et al. (2009) empirically illustrate how new technologies (in this case online portals for customer support) allowed the move of technical repairs online.

The strength of these recent accounts is that they take seriously the mediating role of technology, though the analysis almost entirely focuses on the diminishing role of geographical boundaries. We agree on the importance of studying and conceptualising the mediating role of technology; however, we argue that work across contexts did not emerge with advanced ICTs. As Turbull (2000) vividly illustrated, work across contexts was effectively employed in the 12th century when building Gothic cathedrals. In turn, our study is inspired by these accounts, yet our empirical case and analytical focus is different. The primary aim of our paper is to analyse what challenges actors experience as they conduct similar activities across various contexts.

# 3 Method

Our research approach can be thought of as an interpretive case study because we "aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by its context" (Walsham, 1993, p.4-5).

This article is a collective product. The first author is a researcher who has been exploring collaborative work practices in different organisational contexts in an OGC since 2007. The second author is a senior researcher at an OGC who has been working there for almost 20 years. In this paper, we predominantly draw on the empirical data collected by the first author. The second author has previously conducted studies in similar parts of the company that deal with the operation and maintenance of subsea wells (REFS, suppressed for anonymity). In this work, he addressed the properties of the networked organisation involved in conducting maintenance work at the seabed, together with the support organisation and resources available through bases, vessels and remotely operated vehicles. This work was not directly coupled to LWI, but is relevant to understand the setting. The second author's work was undertaken in 2002-2003 and was useful input in acquiring a better understanding of the historical construction of the LWI in an OGC in a larger picture of subsea activities within the company.

Since 2007, two different business units of the same organisation were studied. One of them was R&D, in which we engaged in conversations with various engineers working in the technology development along with other researchers who were studying organisational issues. The second was Oil and Gas Production, in which we aimed to cover the various disciplines involved in oil and gas production activities. While exploring the second organisational context in March 2009, we were accidentally introduced to a well engineer from the LWI department. After the first interview, which lasted for three hours, we identified several reasons why LWI should be studied in more detail. Firstly, in contrast to various engineers working with a specific oil and gas field, an LWI is working across several oil and gas fields. In that sense, an LWI can be considered as a quite unique organisational unit in an OGC. Secondly, our engagement with LWI was also theoretically driven. Having previously reported on situated work practices (REFS, suppressed for anonymity), we identified LWI as an extreme case (Flyvbjerg, 2006) which has the potential to provide new insights and to challenge existing theory. In the next section, we primarily draw on empirical data from conversations with the LWI department. Other empirical data is either used as background material or to highlight institutional work practices in oil and gas fields.

We employed three modes of data gathering, namely the use of formal and informal interviews, observation and the use of documentary evidence.
In total, 68 in-depth formal interviews, each lasting between one and three hours, were conducted. The first interviews were open-ended, with the goal of identifying strategic IT visions and implementation activities related to collaborative systems. During the later interviews, we analysed specific infrastructural components, work practices or individual engagements with technology. The technological complexity and purpose of a collaborative infrastructure were discussed with developers, administrators and managers of the infrastructure. We conducted 14 formal interviews with actors in this group, and collaborative work practices were explored with actors from several organisational units. Twenty-three formal interviews were performed with various engineers and senior researchers in the R&D department, while 22 interviews were carried out with personnel involved in oil and gas production activities (excluding LWI), in which we interviewed drilling, well, production and process engineers. Nine formal interviews were done with personnel from the LWI

department and five out of eight well engineers with the primary responsibility for planning light well interventions. Additionally, we interviewed one subsea engineer, one well planning manager and one health and safety engineer.

Participatory observation and informal discussions were carried out in multiple organisational contexts. The first author had been granted access to one of the OGC research centres from the beginning of the data collection period. In January 2008, the author was granted office space in addition to access to the building and the OGC's IT network, and spent two to three days per week in the research centre. In March 2009, the author was granted access to the OGC site, a building used by several hundred engineers and other disciplines involved in the activities of a specific oil and gas field. The LWI department happened to be located in the same building. The first author made seven field trips to the OGC site, where he spent a total of 20 full workdays conducting interviews, observing meetings, and having informal chats around a coffee machine or during lunch breaks. Seven out of 20 workdays were devoted to studying the LWI department. The significant amount of time spent on-site helped to form an understanding of how work was carried out in practice as well as the nature of the problems and frustrations that were experienced.

The third major empirical source of data was the internal OGC documents. We undertook an extensive study of the strategic documents related to the planning and implementation activities of the collaborative infrastructure. In addition, we analysed the technical descriptions, formal presentations and training materials of various infrastructural components. A number of presentations, governing documents and formal process descriptions related to LWI activities were studied in detail. Finally, the OGC's intranet portal provided extensive contextual information on the diverse activities of the OGC.

Given our longitudinal study, the data analysis procedures are ongoing and iterative (Boland, 2005). In our faculty, there are several actors (not only the authors of this paper) who are currently exploring collaborative work practices in OGCs, and we often meet and discuss our work. Moreover, a significant part of the data analysis and validation process occurs with the help of OGC employees. During both informal and formal meetings, we frequently present our findings to various OGC employees who challenge, support or direct us to issues that require our further attention.

The empirical data is classified into broad themes that reflect a specific organisational project, practice or technical component. Such a classification is neither all-encompassing nor exhaustive, but rather is characterised by overlapping and continual change. Theoretical considerations have an important role to play in the analysis by providing an analytical means to reclassify the empirical data. As has been previously mentioned, the motivation to study LWI was theoretically driven. Our conversations with LWI engineers were not entirely open-ended, but were aimed at understanding the process of planning light well interventions across different oil and gas fields. Our goal was to identify challenges and practices to overcome them. In the process of writing this paper, we aimed at identifying a set of strategies (Turnbull, 2000) for effective work across oil and gas fields grounded in empirical data, yet which have a relationship to existing theories and are generic enough to be potentially applicable in other settings.

# 4 Case

## 4.1 The organisation

Established only in the 1970s, the global oil and gas company (OGC, a pseudonym) has grown from a small, regional operator in Northern Europe to a significant energy company, currently employing some 30,000 people with activities in 40 countries across four continents. The OGC has a long history of organising work according to hierarchical models and a strict division of labour. Currently, the OGC can be classified as a matrix organisation. The organisational chart splits the OGC into business units, which are responsible for particular functions. As result, oil and gas production from a particular oil and gas field is dependent on a number of different disciplines belonging to different functional units. Additionally, the OGC is heavily investing in establishing and continually improving core business processes. In contrast to a logic of specialisation, processes cut across resource units. Each process is divided into smaller ones, yet the level of granularity and detail varies. Core processes, however, such as drilling and well maintenance are described in extensive detail. Process descriptions outline sequences of activities, the actors involved, the required deliverables and references to other governing documentation. This type of organisation aims at ensuring that the same activity follows the same sequence and produces specified documentation, irrespective of which oil and gas field it is performed in, or which resource unit performs the activity. Another organising principle employed by the OGC is the co-location of different resource units, which are responsible for activities in a particular oil and gas field. In addition to internal matrix organising, the OGC is heavily dependent on multiple external vendors and service companies. The OGC is continually investing in various competence areas, although its core competence is the operation of the entire oil and gas value chain.

### 4.2 Oil and gas production

The oil and gas value chain spans such activities as exploration, well drilling and the optimisation of production. Geophysicists, petrophysicists, drilling and reservoir engineers are all involved in the planning of new wells. While drilling is primarily controlled by drilling engineers, production engineers observe and improve well performance and initiate well interventions during production, which are then performed by well engineers. These activities have a strict division of labour, yet are interdependent and distributed in time and space as the various disciplines work with the same well over a period of many years.

The central object for many disciplines is a well, with the first wells drilled by the OGC in the early 70's. The primary way to drill wells at that time was from platforms, and such wells are called "topside", as wellheads[1] are installed on the platform. Alongside the development of topside wells, the OGC has heavily invested in so-called subsea installations since the 1980's. In contrast to topside wells, subsea wells are completed on the seabed. This means that the wellhead of a subsea well is

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[1] A wellhead is a part of a well which terminates at the surface where hydrocarbons can be withdrawn. The wellhead consists of multiple devices which operate the well and ensure production control.

installed on the sea floor and not on the platform (see Figure 1 for an illustration). As a result, subsea wells are considered to be "invisible", as they are remotely assembled, operated and maintained.

Figure 1 - Illustration of subsea equipment which is remotely maintained by a vessel.

The drilling and completion of a subsea well is five times more expensive than that of the topside type, and subsea wells are usually deployed in combination with topside installations. For example, a satellite field can be developed with several subsea wells if a small reservoir is too far away to drill a well from a platform, though deploying a new platform is not cost-effective. Currently, the OGC is operating approximately 500 subsea wells and "there is a gradual transfer from installations projecting above the sea surface to subsea installations" (OGC intranet news, October 2009).

Wells are drilled in order to extract hydrocarbons from a reservoir to a refinery in the platform where oil and gas is separated and later transported to onshore facilities by tankers or pipelines. A reservoir is a complex and non-linear object which contains not only hydrocarbons, but water and sand as well. Reservoirs differ in their location (depth and surrounding rocks), consistency, characteristics (i.e. temperature and pressure) and size. As a result, the drainage strategy for each reservoir is different. In other words, the amount and type of wells that are drilled varies greatly. Deep-sea and high pressure/temperature wells require special equipment to be installed to ensure flow assurance and prevent leakage. For that reason, wells within and across oil and gas fields vary greatly in their technological complexity.

## 4.3 Well maintenance

Each well is composed of numerous technological devices such as sensors, valves, casing, tubing equipment and other parts. Every device has a certain lifetime, which can be reduced for instance by corrosion or sand production. Wells can become filled with soil, which can be "washed" by injecting chemicals into the well under certain pressure. Given that hydrocarbons located in the reservoir are in constant flux, there may be a need to perforate the well casing to achieve efficient communication between the pockets of hydrocarbons in reservoirs. These activities are called well interventions (WI), and are performed in order to increase oil and gas recovery from reservoirs.

A WI for topside and subsea wells requires distinct intervention technologies. While topside wells are accessed from platforms, subsea well interventions are remotely conducted from mobile rigs or vessels. The first subsea well interventions were conducted from mobile rigs, but the costs were very high and the OGC has been intensively exploring alternative technologies. The concept of LWI emerged as a UK-based company built a vessel capable of performing smaller subsea interventions. The OGC performed the first light well intervention in 2000 and has been committed ever since to this technology due to its high cost saving potential: "deploying a ship rather than a rig for downhole operations in subsea wells cuts the costs of these jobs by roughly 50 percent" (OGC intranet news, December 2004).

While vessels offer significant cost reduction, it is important to note that they do not eliminate the need for mobile rigs, as vessels can only perform smaller interventions. If a well is damaged during an intervention it is most probable that a mobile rig will be required to get the production back on track. Thus, to seize the economic potential, it is important that vessels achieve a high operational efficiency.

## 4.4 Light well interventions – Work across oil and gas fields

In 2006, the OGC made an even greater commitment to subsea interventions and established a "Light Well Intervention" department. The department is a rather small one (30 people), and consists of well and subsea engineers, well planning managers, materials coordinator, health and safety engineers, an economist and a technical assistant who all work onshore and are co-located. In addition, 12 well managers participate in several onshore meetings, although their primary workplace is in an offshore vessel. The core competence of an LWI is the planning and operation of well interventions. Nevertheless, the equipment needed to conduct interventions is provided by several external vendors. The OGC has long-term framework contracts with several vendors, which ensure the quick development or delivery of the necessary subsea equipment. In addition, the OGC has a long-term contract with a shipping company, which provide two vessels for conducting light well interventions.

Given that the OGC is currently operating only two vessels, but there are approximately 500 subsea wells; interventions have to be planned well in advance. Any field in the OGC can be considered as an employer for an LWI. Production engineers from a particular field decide when an intervention has to conducted and report their interest. An LWI has a planning matrix, which outlines how many interventions and where they will be performed in the coming year. Moreover, well interventions are planned in parallel. The local policy of an LWI is that when a vessel leaves the dock to perform an intervention, two additional interventions have to be planned. In case of unexpected situations, a vessel can perform another intervention:

> We [LWI] do not want vessels to be parked in the dock. The vessel that completes an intervention comes to dock, unloads the equipment, and new

> equipment is loaded and the vessel leaves to perform another intervention. This happens continually the whole year round… if the vessel is parked in the docks, we lose money… (LWI well engineer)

An LWI operates across many oil and gas fields, so planning and conducting a new intervention implies the need for collaborating with new actors continuously. Moreover, during the intervention period an LWI is often separated from production engineers who requested an intervention by a geographical boundary. Multiple specialised systems as well as synchronous or asynchronous collaborative tools support this information exchange. In addition, an LWI does not have a constant "employee", but changes as the LWI works across different oil and gas fields. This implies that in contrast to working within an oil and gas field in which knowledge is situated in one geographical area, an LWI operates across 500 subsea wells, which are drilling in multiple oil and gas fields with no in-depth local knowledge. Because of this, an LWI has to get close to local knowledge in order to conduct efficient interventions. Interestingly, without in-depth local knowledge, an LWI has high operational efficiency. Given a lack of local knowledge, how does an LWI perform across many oil and gas fields with a high operational efficiency?

# 5 Analysis: Strategies for getting close enough to local knowledge

In this section, we analyse how LWI engineers are planning interventions across numerous oil and gas fields. Given that LWI engineers do not have in-depth knowledge about all the subsea wells, we analyse how knowledge is transferred, translated and transformed (Carlile, 2004). In Turnbull's (2000) vocabulary we identify a number of strategies that LWI engineers perform in order to overcome differences related to a specific oil and gas field (see Table 1 for a summary).

Table 1. A summary of strategies for getting close enough to local knowledge

| STRATEGY | ACTIVITIES | CHARACTERISTICS OF WELL INTERVENTION | THEORY |
|---|---|---|---|
| Drawing on templates | • Drawing on work process description<br>• Using "personal" templates | This strategy is performed during all interventions. LWI engineers draw on formal or "personal" templates in order to obtain the necessary information about a given well. During this activity, LWI engineers work on their own to a large extent, and have little interaction with other disciplines. | • Plans as resources for situated action (Suchman, 2007)<br>• Knowledge transfer (Carlile, 2004) |
| Filling gaps | • Finding lacking information – either in a particular document or by finding a person. Also entails gaining access. | The number of "gaps" usually increases with a well's age. As a result, LWI engineers are exposed to differences – where particular documents are stored or how they are named. If a well is old, some information might be stored in a physical archive either offshore or onshore. Well engineers have to improvise in order to fill in the gaps. | • Improvisation (Orlikowski, 1996)<br>• Knowledge translation (Carlile, 2004) |
| Sorting uncertainties | • Comparing information from different sources<br>• Gaining information from trustworthy sources | Information about wells (particularly about old ones) is overlapping and duplicated across various IS. The work of comparing information from different sources, identifying mistakes or deciding which source to trust is central in the process of planning well interventions. | • Triangulation (Rolland, 2006)<br>• Working knowledge (Ellingsen & Monteiro, 2003)<br>• Knowledge translation (Carlile, 2004) |
| Drawing on external expertise | • Initiating peer review process<br>• Drawing on OGC and international standards on how to perform interventions in high pressure/temperature wells. | When conducting non standard (i.e. difficult) well interventions, a well planning manager has to find external expertise in order to identify and evaluate various alternatives to ensure that an intervention is planned to a high standard. | • Knowledge translation and transformation (Carlile, 2004) |

## 5.1 Drawing on Templates

Well interventions vary from small ones such as perforation, plug setting, zone isolation or data gathering to large ones such as the replacement of equipment, re-drilling or cementing. The primary aim in performing an intervention is to extract more hydrocarbons from the reservoir. In other words, an economic consideration has to be made as to whether it is worth performing an intervention. Once it has been decided to perform an intervention, production engineers initiate the process of “planning and executing a well intervention”. A 20-page formal OGC description briefly outlines the main activities, the actors involved and the main deliverables. This work description functions as a “resource for situated action” (Suchman, 2007). The first deliverable of this process is the so-called “Well Intervention Assignment”, which is a document completed according to a prepared template by production engineers. A WIA outlines what type of intervention has to be performed and specifies production and reservoir related information. During a “start-up” meeting, production engineers present the WIA document and relay the process to the well engineers. Given that a WIA document contains only general information about the well, reservoir and oil and gas production, well engineers have to perform a historical reconstruction of a well in order to plan an intervention.

As outlined above, well engineers who plan interventions for topside wells can plan a standard intervention in less than a week, though light well intervention planning requires at least one month. Two well engineers are involved in the planning. One of them is called a “co-pilot” and assists or can replace the main engineer in unforeseen situations. The planning process is laborious and uncertain. A well has to be reconstructed as precisely as possible, but the information that has to be found varies with the type of intervention that needs to be conducted.

As one engineer explained, “LWI is young and we do not have a good best practice”, yet certain technical information about a well is a “must have”. Such information includes drawings (with coordinates) on how the well is drilled, what equipment is installed, the diameter of a well, how the well was completed and previous experience reports. How each engineer performs this information search varies, although some draw on templates in order to make the planning process more systematic. A template in this case is an MS Word file listing from which systems information needs to be obtained or specific documents have to be found. As engineer plans the intervention he/she makes notes in the template and adds links to various documents. The use of a template ensures that certain information or the source of the information is not unintentionally forgotten. It is important to note that the use of a template does not imply an autonomous information search. To the contrary, as stated in the template, some information needs to be obtained from a platform’s control room by calling them:

> I always call the control room and ask whether a well has certain constraints… this well for instance "needs to be beaned up [i.e. started] carefully due to sand production" (A well engineer reads a note from a template)

Information obtained by drawing on a template is eventually used in a "well intervention program" (WIP) document, which describes in detail how the intervention will be performed. If well engineers have access to most of the necessary information sources and the planned intervention is rather simple (e.g. data gathering), the planning process is rather quick and can be done quite autonomously (i.e. there is little interaction with production engineers or other disciplines that work around a given well).

### 5.2 Mapping differences and filling gaps

If a well intervention is undertaken in an old well, or an LWI will work in a new oil and gas field, the speed and means of filling the template change. Certain parts of the template are filled out, yet multiple gaps are identified. Since an LWI is working across many oil and gas fields, well engineers are exposed to differences. For instance, the so-called "final well report" (FWR) document has to be analysed during the planning process. The FWR summarises experiences, outlines the equipment used and the challenges experienced. How this document is labelled (i.e. the file name) varies across platforms and can be written in different languages. Additionally, it can be stored in different databases, or in the case of old wells, in an offshore or onshore archive. If a well engineer works in a specific oil and gas field for the first time, then these variations are unknown and as one engineer explained, "there are no automatics then… you have to ask people". In short, well engineers have to improvise (Orlikowski, 1996) in order to fill the gaps.

A close collaboration with the production engineers who initiated the intervention is done with the help of phone calls and e-mails, and is crucial for identifying where the well information is stored. Production engineers, however, do not have all the required information about subsea installations, as their primary focus is on production data. For this reason, well engineers have to find other people who were or currently are involved in particular activities around a given well. For instance, in order to find the completion reports, "you have to know the rig [who did the completion], and then you can trace who was responsible for completion" (LWI well engineer).

Well engineers do not always need help in order to identify where specific information is stored, but even knowing where the information is stored could require additional effort in order to attain access to it:

> If we [LWI] will work with an old well, the information is not necessarily stored in [name of a collaborative system], and it is quite plausible that you have to dig in various archives [electronic and physical], which are usually not accessible by everyone. If it is an electronic archive, you need to get access to it, which can take a lot of time… So I have to find a person who has the authority to give access. Nobody has access to everything… the company is too big… (LWI well engineer)

As demonstrated, mapping out differences and gaining access requires an active collaboration with various actors from certain oil and gas fields. It is also the case that the same information can be found in different "places". During an interview in a conference room a well engineer nicely characterized such a situation: "there are many doors to a room". While the phrase does not apply to all rooms, it certainly did for the room we were sitting in.

Sometimes, well engineers are not capable of finding specific information even with the practices mentioned above. The "last chance" is to contact subcontractors [an external company] that were working with a specific well a long time ago:

> If [name of the company] did the completion and I cannot find any documents here [at the OGC], I can call them and ask whether they have it. I did this a couple times and actually got the information. (LWI well engineer)

### 5.3 Sorting uncertainties

From 2003 to 2010, the OGC performed about 80 light well interventions. Some interventions are performed in the same oil and gas field or even at the same well. As a result, coming back to the same oil and gas field or well makes the planning process easier:

> I am planning a well intervention now, and the problem with this well is that it has a broken safety valve… we [LWI] have actually been in this well during the last year. This means that they [LWI engineers who did the previous intervention] have done a lot of work, they have retrieved information from different databases… it makes my work much easier. As an exercise, it can be OK to go through different specialist systems to check if some information is missing… just to double-check. (LWI well engineer)

The quote above highlights the fact that engineers trust each other's work; however, the crucial aspect is that previously collected information is not taken for granted. As the well engineer explained, information needs to be "double-checked". Indeed, the work of comparing information from various sources, identifying mistakes or deciding which source to trust is central to the process of planning well interventions. This process is similar to triangulation activities, which in qualitative methodologies aim to increase the validity of findings by obtaining data from multiple sources (Robson, 2002, p.174).

Triangulation for LWI well engineers is a rather informal activity and the extent to which it is practiced varies. The need for triangulation increases if an intervention is performed in an old well or the complexity of the intervention is high. Given the overlapping or sometimes duplicate information across numerous systems, it is crucial to identify which information source is reliable:

> All of us should be aware that information in [name of the system] is not always correct. Preferably, it should be double-checked and compared with other sources, for instance, [name of the system]. For example, information

> about equipment can be slightly wrong… for instance, the wrong diameter… it is critical for us to have the correct information since we will have to put equipment in the well [if the equipment used for intervention is too large, it can become stuck in the well] (LWI well engineer)

While certain systems are considered "unreliable" and require double-checking, other systems are considered to be key and are trusted more, or as a well engineer explains, "even if we are not 100% sure, we have to trust [name of the system]".

"Double-checking" is not a straightforward activity; it requires experience in order to analyse information and identify whenever it is correct:

> I do not have a lot of experience [a person who has three years experience as a well engineer] and the scary thing with [name of the system] is that I do not necessarily identify mistakes. He [referring to a colleague] can identify mistakes because he was working with wells for 15 years… certain mistakes you can identify… you can identify that some things are not physically possible... for instance, the diameter of two connected pipes cannot be very different… so some mistakes one can identify, but not all. (LWI well engineer)

Much the same as identifying a reliable information system, particular persons (a person with specific role) are trusted more than others. If one needs to find information about well completions, it might require finding the person who was responsible for the completion of a particular well. Other actors who work with a specific well on a daily basis are also considered as being trustworthy:

> If I lack specific information or I feel uncertain about something I call an operator [a person working offshore in the platform's control room]. If there are certain limitations in the well, the platform knows about them. So I can talk with an operator and ask. They could say for instance that the annulus pressure should not be higher than 50bar… and then I know this [i.e. that the

> information is correct] because I have talked to a person who works with that well in the platform every day. (LWI well engineer)

## 5.4 Drawing on external expertise

The triangulation activities illustrated in the previous section are initiated and carried out by well engineers when planning a well intervention. Which sources (persons or information systems) are "double-checked" and whether certain mistakes are identified depends on the person who plans the intervention. An engineer who invests more time in obtaining information from trustworthy sources or who has more experience about well technologies has a greater chance to reconstruct the well more precisely. As the complexity of intervention increases, the interaction with disciplines that work around a given well might not be sufficient and could require additional expertise. In particular, external expertise is a necessity if a well intervention is a non-standard one.

Well planning managers have the responsibility to ensure that interventions are planned to meet a high standard. Their role is especially important when planning unfamiliar or complex interventions, as they initiate so-called peer assist and peer review processes. Both processes are aimed at assisting well engineers during planning and improve the overall quality of the planned intervention. Well planning managers initiate peer assist/review processes and assemble a team of engineers who may have experience with a specific technology or problem, in addition to other professionals, to ensure that an intervention is planned in the best possible way. It is important to emphasise that expertise in peer review/assist processes is not necessarily gained from the people who have in-depth knowledge of the well where the intervention will be performed. While production engineers or operators in the platform might have in-depth local knowledge of a particular well, they do not necessarily have the type of knowledge of technologies or methods needed to perform an intervention.

A peer assist process is initiated quite often and well engineers refer to it as a "simple" examination of a planned intervention. On the other hand, a peer review is a more formal and intense process, which requires a series of meetings or workshops in order to assess whether the planned intervention meets formal requirements. A peer review is initiated for non-standard operation. For example, some well interventions cannot be performed according to an OGC's policies. For instance, while OGC policies specify that two barriers have to be established in order to have the possibility of "killing" a well in emergency situations it is not always possible to do it due to technical constraints. In such cases, the risk matrix produced by well engineers would contain a red colour (high risks), though as one well planning manager explains, "we can sometimes deviate from OGC policies". In these types of cases, a peer review process would be initiated. For the well planning manager, "it is crucial to find people [various engineers from different OGC departments] that have experience with certain issues in order to have a professional discussion". According to well engineers, the peer review process cannot prevent operational incidents, yet the planned intervention becomes more "robust".

# 6 Discussion

This paper has focused on the ways in which similar work is performed across multiple contexts. The paper is addressing existing theoretical overemphasis that work practice is bound to local contingencies. While theory suggests that performing similar activity across multiple contexts would be very difficult if possible at all throughout the paper we have illustrated that cross-contextual practice (i.e. the one that span across multiple contexts) is a regular phenomena for well engineers who maintain wells across numerous oil and gas fields. The core question then is why current theory falls short to explain such practice. In what follows, we identify two interrelated issues that need to be elaborated in order to explain cross-contextual work practice, namely what exactly 'local' is? and how different 'localities' are?

The notion of 'local' is usually restricted to the context of action (Suchman, 2007), such as individual actors' engagement with technology (Orlikowski). As Timmermans and Berg (1997, p.275) suggested, universality is local and "always rests on real-time work, and emerges from localized processes of negotiations and pre-existing institutional, infrastructural, and material relations”. In turn, ambitions to standardise work practices across contexts in the end produce diversity.

As organisation scholars suggested ‘local’ can be also charted with formal and informal boundaries, such as such geographical, organisational, disciplinary, technological, and historical (Orlikowski, 2002). Undoubtedly more boundaries can be identified, however the striking aspect is that most of these boundaries are actually effectively spanned in practice. As we have illustrated in the analysis section well engineers apply a repertoire of strategies in order to span multiple boundaries. One of the ways to address the problem of local is to discuss the salient aspects of boundaries and analyze: where the boundaries are drawn? who is drawing them? and how high the ‘fence’ of a boundary is?

We find that the current literature usually denotes ‘local’ to a small geographical location or organisational unit. Such a way of understanding organisation, however, relies on rather clear-cut classification, such as formal division of labour. This way of conceptualizing ‘local’ might need a revision. Given our empirical data, we argue that ‘local’ can be scaled up.

We have illustrated that LWI is quite unique community in OGC, yet one way to explain the capacity to work across multiple ‘localities’ would require relating LWI engineers to well engineers in particular and subsurface community in general. Well engineers working with subsea or topside wells share a common ground. While technologies to perform intervention are different, technologies that are installed in the well are similar. As result, well engineers do not have to cross a high barrier in order to work either with topside or subsurface wells. In addition, well engineers share similar educational background. Work across 500 subsea wells can be considered as work within the same community but across different geographical locations, which each of them has certain differences.

The notion of ‘difference’ is central for drawing multiple boundaries and according to Carlile (2004) differences relate to non-similarity in “levels of experience, terminologies, tools, and incentives that are unique to each specialized domain” (ibid., p.556). Having established that each ‘location’ has its own ‘local’ peculiarities it is crucial to elaborate how significant the differences are. The core differences in our case relate to the different ways of working around a well along time and space dimensions. Work practices not only vary across oil and gas fields, but they also change over the time. OGC is technology-intensive organisation and technological innovations such as subsea technologies allow new forms of organising. Yet it requires organisational changes such as establishment of specific departments and new work practices to seize new possibilities. In turn, this implies that the 'same' work such as well maintenance is performed with different technologies, documented in varying detail, labelled differently and stored in different database or a specific paper-based archive. Due to well's long life cycle, the person who was responsible for specific task might not be present either. In short, this would suggest that working across such heterogeneous and changing environment is hardly possible due to differences.

In order to understand how such work is possible in practice Carlile (2004) proposed that differences can be sorted-out along three dimensions: syntactic, semantic, and pragmatic. The different ways of labelling particular information relate to syntactic differences. Well engineers experience semantic differences with production engineers or when confronted with similar information about the same issue, yet coming from different sources. Pragmatic differences are quite rare in our case, but the best example is collaboration among different disciplines when well intervention deviate from OGC policies. In our case, then, it is actually syntactic and more seldom semantic differences that well engineers are confronted with. As we have illustrated, well engineers enact a repertoire of strategies, which account for specific differences. Syntactic differences are resolved with process descriptions, personal templates and little interaction with production engineers. In order to bridge semantic differences it requires more social interaction. Pragmatic differences are currently handled with 'peer review' process, during which multiple actors challenge the planned intervention, yet have to make a common decision in the end.

Taken these issues together our empirical case suggests that cross contextual work practice rely on a combination of standardisation efforts to establish a common syntax (such as plans, process descriptions and other formal documentation) and ad-hoc strategies, in order to resolve cross-contextual differences and get close enough to local. Similar to Carlile's (2002, 2004) work, our findings suggest that the role of formal documentation (common syntax) should not be underemphasized as it functions as the only resource for non-complex activities. As the complexity of task (in our case well intervention) is increasing it progressively requires more social interaction and engagement with various technologies (i.e. socio-technical strategies) in order to resolve cross-contextual differences and get close enough to local.

# 7 Conclusions

This paper illustrates how emergence of new subsurface technologies in the oil and gas industry requires new forms organizing. While previously well maintenance was a local activity, now subsea well maintenance relies on a cross-contextual work practice, the one that spans across multiple contexts. Presented empirical case was deliberately chosen to discuss the existing theoretical overemphasis that work practice is a predominantly a local affair.

In line with previous research, the paper illustrated how engineers working across contexts encounter differences, which we relate to syntactic, semantic, and pragmatic levels (Carlile 2002, 2004). More importantly, however we have illustrated how engineers employ a variety of socio-technical strategies in order to get close enough to "local" and perform well maintenance activities in a cost-effective and safe manner. Our findings relate to the recent discussions on the 'locality' of action (Pollock, et al., 2009; Vaast & Walsham, 2009). The primary contribution of the paper is an empirical and analytical discussion of how similar work is carried out across different contexts. Utilization of Carlile's framework (2002, 2004) does also increase precision when addressing differences and similarities of work (Leonardi & Barley, 2008).

This study provides insights on cross-contextual work practices in oil and gas company, yet other empirical examples from various industries are needed for further discussions. We suggest that further research should aim at presenting empirical examples, which demonstrate socio-technical interactions, connections and dependencies across contexts. While our study demonstrates that work across contexts is possible, we are cautious to generalise and suggest that further studies should inquire in how much difference can actors tolerate when working across contexts. We believe that such research direction has a significant contribution for theories of practice.

# 8 References


Bechky, B. A. (2003). Sharing meaning across occupational communities: The transformation of understanding on a production floor. *Organization Science, 14*(3), 312-330.

Bijker, W. E. (1992). The Social Construction of Flourescent Lightning, Or How an Artifact Was Invented in Its Diffusion Stage. In W. E. Bijker & J. Law (Eds.), *Shaping technology/building society: studies in sociotechnical change* (pp. 75-102). Cambridge, Mass.: MIT Press.

Boland, R. J., Jr. (2005). Interpretation and theory in qualitative research. In R. Solli, S. Tengblad & B. Czarniawska (Eds.), *The art of science* (pp. 219-236). Malmö: Liber.

Boland, R. J., Jr., & Tenkasi, R. V. (1995). Perspective making and perspective taking in communities of knowing. *Organization Science, 6*(4), 350-372.

Boudreau, M.-C., & Robey, D. (2005). Enacting Integrated Information Technology: A Human Agency Perspective. *Organization Science, 16*(1), 3-18.

Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization Science, 13*(4), 442-455.

Carlile, P. R. (2004). Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries. *Organization Science, 15*(5), 555-568.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry, 12*(2), 219-245.

Gasser, L. (1986). The Integration of Computing and Routine Work. *ACM Transactions on Office Information Systems, 4*(3), 205-225.

Leonardi, P. M., & Barley, S. R. (2008). Materiality and change: Challenges to building better theory about technology and organizing. *Information and Organization, 18*(3), 159-176.

Levina, N., & Vaast, E. (2005). The Emergence of Boundary Spanning Competence In Practice: Implications For Implementation and Use of Information Systems. [Article]. *MIS Quarterly, 29*(2), 335-363.

Morgan, G. (2006). *Images of Organization*: SAGE Publications.

Orlikowski, W. J. (1996). Improvising Organizational Transformation Over Time: A Situated Change Perspective. *Information Systems Research, 7*(1), 63-92.

Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization Science, 11*(4), 404-428.

Orlikowski, W. J. (2002). Knowing in practice: Enacting a collective capability in distributed organizing. *Organization Science, 13*(3), 249-273.

Orr, J. E. (1996). *Talking about machines an ethnography of a modern job*. Ithaca, N.Y.: Cornell University Press.

Pollock, N., Williams, R., D'Adderio, L., & Grimm, C. (2009). Post local forms of repair: The (extended) situation of virtualised technical support. *Information and Organization, 19*(4), 253-276.

Robey, D., & Sahay, S. (1996). Transforming work through information technology: A comparative case study of geographic information systems in county government. *Information Systems Research, 7*(1), 93-110.

Robson, C. (2002). *Real world research a resource for social scientists and practitioner - researchers* (2nd ed.). Oxford: Blackwell.

Rolland, K. H., & Monteiro, E. (2002). Balancing the local and the global in infrastructural information systems. *Information Society, 18*(2), 87-100.

Savigny, E. v., Knorr-Cetina, K., & Schatzki, T. R. (2001). *The Practice turn in contemporary theory*: Routledge.

Shapin, S. (1995). Here and Everywhere: Sociology of Scientific Knowledge. *Annual Review of Sociology, Vol. 21*, 289-321.

Soh, C., Kien, S. S., & Tay-Yap, J. (2000). Cultural fits and misfits: Is ERP a universal solution? *Association for Computing Machinery. Communications of the ACM, 43*(4), 47.

Star, S. L., & Griesemer, J. R. (1989). Institutional Ecology, Translations and Boundary Objects - Amateurs and Professionals in Berkeleys-Museum-of-Vertebrate-Zoology, 1907-39. *Social Studies of Science, 19*(3), 387-420.

Suchman, L. A. (2007). *Human-machine reconfigurations : plans and situated actions* (2nd ed.). Cambridge: Cambridge University Press.

Timmermans, S., & Berg, M. (1997). Standardization in action: Achieving universalism and localisation through medical protocols. *Social Studies of Science, 27*(1), 273-305.

Turnbull, D. (2000). *Masons, tricksters and cartographers : comparative studies in the sociology of scientific and indigenous knowledge*: Amsterdam : Harwood Academic.

Vaast, E., & Walsham, G. (2009). Trans-Situated Learning: Supporting a Network of Practice with an Information Infrastructure. *Information Systems Research, 20*(4), 547-564.

Walsham, G. (1993). *Interpreting information systems in organizations*. Chichester: Wiley.

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**To Whom It May Concern**

**Statement of authorship on joint publications to be used in Gasparas Jarulaitis PhD-thesis**

(Cf. NTNU PhD-regulation § 7.4, section 4 and dr.philos regulation § 3, section 5)

As co-author on the following joint publications in Gasparas Jarulaitis PhD-thesis:

1. Hjelle, T. and G. Jarulaitis 2008. Changing Large-Scale Collaborative Spaces: Strategies and Challenges. *Proceedings of the 41st Hawaii International Conference on System Sciences*, Hawaii.

I declare that the candidate's contribution to this work is correctly identified in the thesis and that I consent that this work is to be used as part of the thesis.

31/8-2010
Date

Torstein Hjelle
Torstein Elias Hjelle

**To Whom It May Concern**

**Statement of authorship on joint publications to be used in Gasparas Jarulaitis PhD-thesis**

(Cf. NTNU PhD-regulation § 7.4, section 4 and dr.philos regulation § 3, section 5)

As co-author on the following joint publications in Gasparas Jarulaitis PhD-thesis:

1. Jarulaitis, G. and E. Monteiro 2009. Cross-contextual use of integrated information systems. *Proceedings of the 17th European Conference on Information Systems*, Verona, Italy.
2. Jarulaitis, G. and E. Monteiro 2010. Unity in Multiplicity: Towards Working Enterprise Systems. *Proceedings of the 18th European Conference on Information Systems.* Pretoria, South Africa.

I declare that the candidate's contribution to this work is correctly identified in the thesis and that I consent that this work is to be used as part of the thesis.

30/8-10
Date

Eric Monteiro

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**Statement of authorship on joint publications to be used in Gasparas Jarulaitis PhD-thesis**

(Cf. NTNU PhD-regulation § 7.4, section 4 and dr.philos regulation § 3, section 5)

As co-author on the following joint publications in Gasparas Jarulaitis PhD-thesis:

1. Jarulaitis, G. and V. Hepsø 2010. Cross-contextual work practice: Investigating strategies for navigating across islands of knowledge. Submitted to the *Information and Organization* journal

I declare that the candidate's contribution to this work is correctly identified in the thesis and that I consent that this work is to be used as part of the thesis.

3/9-10
Date

Vidar Hepsø
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