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Unity in Multiplicity: Towards Working Enterprise Systems

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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.

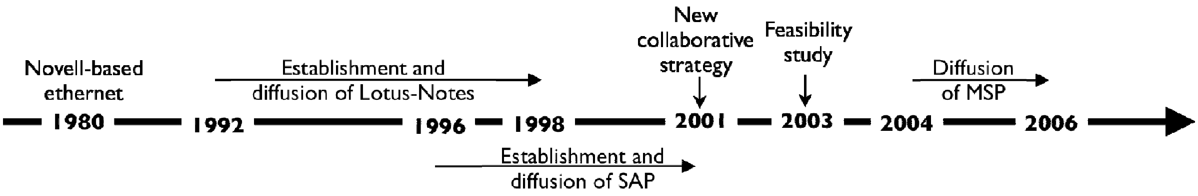


Figure 1. Timeline illustrating the implementation of enterprise systems OGC

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:

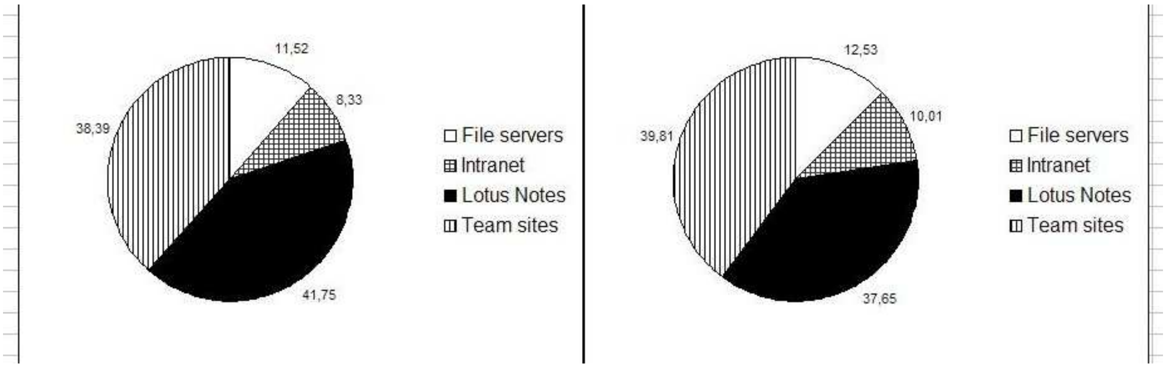
> "we know that another field [oil and gas field] create TSs for disciplines, but we have TSs for business processes… I think it is more correct to do in our way… we are primarily working with one platform and have a dedicated team site for that, but there are two other platforms in this field. Sometimes 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.

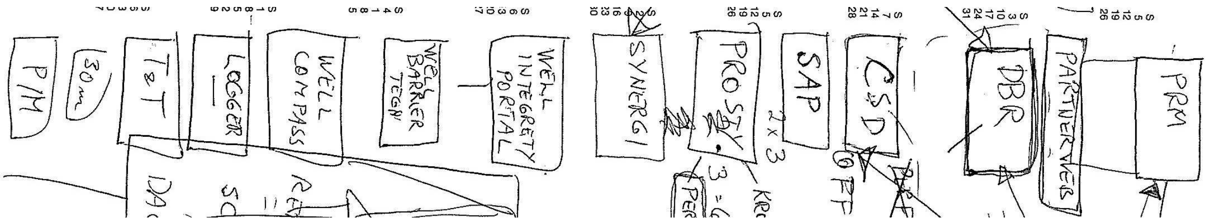


Figure 3. Fragmentation of well information across multiple systems

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.

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

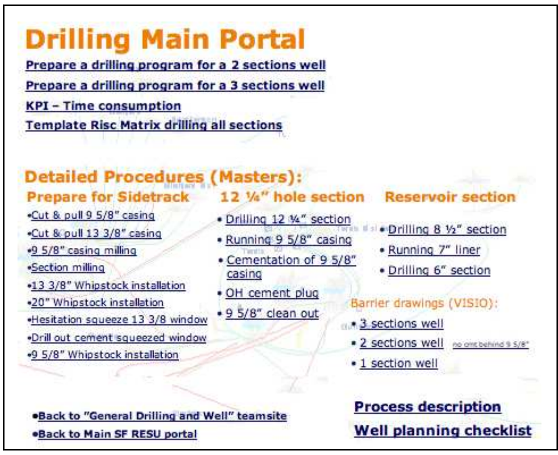


Figure 4. Index for well planning

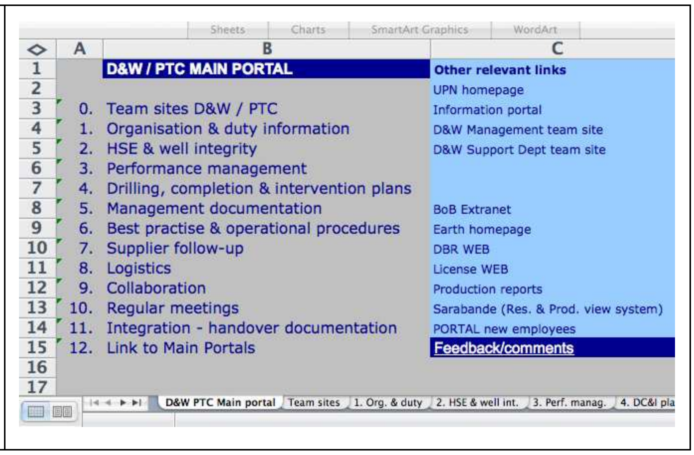


Figure 5. Index for well and production activities

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.

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