Systemic Practice and Action Research, Vol. 15, No. 2, April 2002 (© 2002)

Purity and Danger of an Information Infrastructure

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Received May 15, 2001; accepted January 5, 2002

We critically assess deep-seated assumptions and images of an information infrastructure, namely, that it needs to be uniform, tidy, and nonfragmented. This is necessary because our perception of order is socially constructed and, more importantly, because it has implications. Based on an historical reconstruction of the establishment of a Lotus Notes-based infrastructure in an internationally oriented oil company with 17,000 employees, we describe and analyze the productive role that appeals to an orderly infrastructure play. We trace its sources and describe how it operates. We also identify the implications in terms of choice of technological solution, delegation of organizational roles, and making organizational actors (in)visible.

KEY WORDS: information infrastructure; actor–network theory; purity; fragmentation; Lotus Notes; rituals.

1. INTRODUCTION

Dirt is matter out of place.

Douglas (1966)

The development, introduction and widespread use of a comprehensive information infrastructure is a resource-consuming effort spanning years. It brings together and superimposes a range of technical, organizational, strategic, and economic issues (Ciborra, 1996; Kahin and Abbate, 1995; Weill and Broadbent, 1998). The infrastructure is negotiated across these issues rather than belonging properly to any one.

A commonly held ambition is to integrate the various applications, platforms, and information systems that exist. The rhetorical thrust of the vision of tidying

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1094-429X/02/0400-145/0

up—sweeping old mess aside—to avoid fragmentation and chaos is strong. It is one of the driving ideas behind the notion of a comprehensive and versatile infrastructure. But the fragmentation, of course, exists for good reasons and will not simply be swept away.

Our aim is to analyze an important but neglected aspect of the sociotechnical process of establishing an information infrastructure. We empirically study and analyze how symbolic visions, images, and icons of a nonfragmented infrastructure act as forceful "actors" that contribute substantially to the shaping of the technology (Pfaffenberger, 1998; Swanson and Ramiller, 1997). The necessarily open-ended nature of any information infrastructure—its generic character, or its ability to function as a boundary object (Star and Griesmer, 1989)—implies that images and metaphors play a particularly productive role as a powerful ally (Boland and Greenberg, 1992; Star and Ruhlender, 1996). We are concerned with the following set of questions: How are our concepts of an orderly information infrastructure constructed? Which mechanisms are at play in achieving the "natural" or taken-for-granted character of this order? What are the different forms of order in relation to information infrastructure? What are the implications of constructing order in a given way? Whose voices are silenced by the prevailing construction of order? and What are the implications for the development and use of information infrastructure?

The remainder of this paper is organized as follows. Section 2 outlines a theoretical approach to our study of order as an ongoing social, technical, and symbolic process drawing primarily on actor–network theory (ANT) and supplemented with Douglas' (1966, 1986) notion of "dirt," which we argue should be interpreted as "fragmented" in relation to information infrastructure. In Section 3, the context of the case is outlined, namely, the Norwegian-based but internationally oriented oil company Statoil, with about 17,000 employees. Section 4 describes and reflects upon the research methodology. Sections 5 through 8 contain the case. It is the historical reconstruction of the development and introduction of a Lotus Notes-based infrastructure in Statoil during the years 1992–1998. We highlight how the fear of fragmentation was constructed, how it was circulated and reproduced, and how this blocked alternatives. In the analysis in Section 9, we focus on three issues. First, we discuss how a given sense of order came to be "obvious" or taken for granted. In social constructivist thinking, this is never obvious but rather a produced outcome of a process. In our case, an important element in this process was the rituals performed to confirm and reestablish the prevailing order. Second, we discuss how the constructed order failed to be neutral; it inscribed work routines and delegates roles to the organizational actors. Third, we study the strategies at work in the punctuated episodes when the prevailing sense of order was challenged. This evoked, we argue, deep-seated sentiments about the alleged dangers of these alternatives. Section 10 offers a few concluding remarks about the

more general implications of our study for the development and use of information infrastructure.

2. THEORY

Developing information infrastructures has traditionally been regarded as a predominantly technical endeavor (Gunton, 1989). This is no longer the case. It is a rapidly expanding body of literature addressing an array of issues of social, economical, institutional, political, and strategic nature (Dutton, 1997; Kahin and Abbate, 1995). Most relevant to us is the subset of this literature focusing on how the development and use of information infrastructure are intervowen with social and strategic issues in business organizations (Weill and Broadbent, 1998; Ciborra, 1994, 2000; Davenport, 1998; Earl, 1996).

Our aim is to explore in some detail a key issue concerning information infrastructures, namely, the background, forms, and organizational responses to the fragmentation of information systems. As Davenport (1998, p. 123) underscores in relation to the particular instance of an information infrastructure of Enterprise Resource Planning (ERP) systems, "You first need to understand the problem [ERP systems] are designed to solve: the fragmentation of information in large business organizations."

This problem has been attempted to be framed as a technical one through the notion of data warehousing (Gardner, 1998). The core idea here is to curb the increasing fragmentation by packaging the data by presenting them through a uniform front end. There is, however, little attention paid to understanding the sources of this diversity. In much of the MIS literature (Broadbent and Weill, 1998; for a critique see Ciborra, 1997), the problem of fragmentation is basically portrayed as the result of a lack of (adherence to) an IT strategy. The remedy, then, is a better "alignment" with the business strategy (Knights *et al.*, 1997; Ciborra, 1997). There is a tendency, however, to emphasize the planned and controlled aspect of such an effort vis-à-vis the more drifting (Berg, 1997; Ciborra, 1996, 1997) and improvised (Orlikowski, 1996; Monteiro and Hepsø, 2000) ones. This downplays to the level of nonexistence the organizational politics that account for why the problem of fragmentation is a real problem.

Within the field of science and technology studies in general and actor–network theory (ANT), in particular, there exist rich descriptions of the mobilization that underlie real implementation projects. Support needs to be gained and sustained through a mobilization process of actively enrolling actors, forging compromises, and making the technology act as a spokesperson on your behalf (Bijker and Law, 1992; Hanseth and Monteiro, 1996; Latour, 1996, 1999; Monteiro and Hepsø, 1998). Our approach to the study of information infrastructure leans heavily on the elaboration of ANT by Star and Bowker (Bowker and Star, 1994,

1999; Timmermans *et al.*, 1995; Star and Ruhlender, 1996). The very activity of classification is an effort to establish categories that help produce order (Douglas and Hull, 1992). Fragmentation of information systems represents a specific kind of "nonorder." To understand fragmentation, it is essential to grasp how order is established through the construction of categories. In their continuing series of studies of classification schemes and infrastructures, Bowker and Star identify a number of issues which are highly relevant to our study. In their historic study of the evolution of the classification of diseases maintained by the World Health Organization, Bowker and Star (1994, 1999) illustrate how coding and classification are anything but neutral. Interests are inscribed into the material of coding schemes. Timmermans *et al.* (1995) studies how some aspects of work are made more visible than other by inscribing them into a classification scheme.

We fully embrace this perspective that emphasizes how technical efforts like that of establishing a working information infrastructure require an ongoing mobilization process. Projects and plans need to be *performed*; they do not unfold autonomously by themselves. The focus on the central role of achieving order through socially constructed categories is very relevant to our analysis of information infrastructures. Few have put this point as clearly as Foucault (1970). His famous citation (Foucault, 1970, p. xv; also cited by Bowker and Star, 1999) from an ancient Chinese classification of animals makes the socially constructed character of the categories rather evident. Relative to our own sense of order, classifying animals into categories including those "belonging to the Emperor," "stray dogs," and those "drawn with a very fine camelhair brush" strikes us as ridiculous. The upshot of this is to realize that order is never given, but the outcome of an ongoing, sociotechnical mobilization process. Our aim is to question the prevailing order and "discover that these orders are perhaps not the only possible ones or the best ones" (Foucalt, 1970, p. xx).

In our analysis of information infrastructures, we do not merely want to reiterate the, by now familiar, theme that technology is socially constructed (Orlikowski, 1996; Walsham, 1993). We want to explore this further by inquiring into *how* order is performed: How does it manifest itself? How does it gain support and become productive? and What are its different forms in connection with establishing a working information infrastructure?

The analysis of how social order gets constructed has, of course, deep roots in the social sciences. Durkheim's (1915) agenda was to analyze how social order was possible, that is, how moral feelings and social attachments could develop in diverse social groups. A key mechanism, according to Durkheim, was through a variety of rituals. Durkheim identified religion as an exemplary case of how social practices produced feelings of solidarity. Hence, Durkheim did not grant religion a special status; it employed the same basic mechanisms as other cases. Of special interest is the way he describes how groups tend to perform rituals of respect

for its sacred objects. Rituals are, according to Durkheim, the group worshipping themselves.

Douglas (1966) contributes with a highly relevant description of how order gets constructed. The reason that order and categories are so entrenched, Douglas argues, is that they are intrinsically linked to fundamental aspects of social life and sense making. This is what makes our world a comprehensive one. Order in social life is the existence of symbols that mark borders and systems of classifications. The symbols that rituals select and interpret filter experience by communicating cultural themes and excluding unknown themes. The structuring of our experience evolves through a system of binary oppositions, such as clean/dirty, good/evil, black/white, inside/outside. These categories make it possible for us to understand when we are entering or leaving a symbolic border. We are socialized into thinking that things are dirty in themselves, that is, that dirt is an attribute of an object. But if this is really the case, Douglas asks, how may we then account for the fact that most people regard it as dirty to put your shoes on the table but not on the floor? Douglas' account, in essence, is that it is a misconception to think of dirt as a given category and an attribute of an object. An object is dirty, according to Douglas, when it transgresses the socially constructed categories of order.

Having elaborated how Douglas and social studies of science pave the road for an empirically open notion of order, it remains to spell out how this ties in with the development of information infrastructure. The link, we argue, is through the status of fragmentation:

> Where there is dirt there is a system. Dirt is a by-product of a systematic ordering and classification of matter, in so far as ordering involves rejecting inappropriate elements. . . . In short, our pollution behaviour is the reaction which condemns any object or idea likely to confuse or contradict cherished classifications. (Douglas, 1966, pp. 35–36)

Douglas essentially opens up for a relative notion of dirt. Dirt is not an attribute of an object but rather relative to socially constructed categories as social studies of science and technology have since iterated so convincingly (Berg, 1997; Bijker and Law, 1992; Bowker and Star, 1994; Latour, 1996; Timmermans *et al.*, 1995). Hence, neither categories nor conceptions of what represents order are neutral. Order is neither given nor neutral.

Fragmentation of an information infrastructure represents the opposite of order as "uncleaness or dirt is that which must not included if a pattern is to be maintained" (Douglas, 1966, p. 40). Maintaining an orderly information infrastructure then translates into the ongoing effort to keep it pure, that is, tidy or clean, by preserving the given categories and avoiding the transgression that fragmentation would produce.

In what follows, we extend the insights of ANT where technological efforts are recognized as ongoing processes of mobilization by interpreting Douglas'

emphasis on mundane, everyday rituals as important elements of this mobilization process underlying the contruction of an orderly information infrastructure. In short, we extend the sociotechnical perspective of ANT with stronger symbolic and ritual elements borrowed from Douglas' analysis of dirt.

3. STATOIL

Statoil is a young company. Founded in 1972 with only one employee, it has since grown to a $7 billion operations profit enterprise with over 17,000 employees in 25 countries. The major activities are still located in Scandinavia and northern Europe. After Phillips found the substantial oil field Ekofisk on the Norwegian continental shelf in 1969, there was an ongoing political debate in Norway about how to organize oil production. The decision to establish a new company, Statoil, with the Norwegian state as sole shareholder, was reached in a consensus vote in Parliament in 1972. It was anything but obvious. There was also strong lobbying by the Prime Minister to let Norsk Hydro take charge (internal newspaper, Status 16, Sept. 1992, pp. 8–9). The argument for Norsk Hydro was that it was safer to trust a company that had already proven to be capable and competitive in energy production than to establish a new organization from scratch.

Immediately after Statoil was established, the oil crises struck. For Statoil, the crises had two important consequences. First, it shifted power and control out of the hands of the "seven sisters," the dominating oil companies, and in the direction of the oil producers, primarily OPEC, but also Statoil and Norway, which preferred to stay out of OPEC but with the status of an observer. Second, and of crucial importance, it paved the road for a significant rise in oil prices throughout the 1970s and into the 1980s. Without this rise, the development of the inaccessible oil fields on the Norwegian shelf, deep under the turbulent North Sea, would simply not be cost-effective.

Statoil was the product of negotiations in Norwegian politics. From the outset, Statoil relied heavily on an array of different favorable measurements aimed at tilting the competition. This reliance on political negotiations has made Statoil particularly responsive and sensitive to signals in the political environment.

The broad political obligation in Norway systematically to favor Statoil gradually faded away as the tide of liberalism rose. This has, step by step, forced Statoil through a metamorphosis. It has, through a sequence of small steps, been transformed into an internationally competitive oil and gas producer.

There are a number of organizational actors involved in our case study. Their actions and interests are elaborated further below. To assist the reader in keeping track of these actors, we provide a crude description of them in Table I that may be consulted as needed.

Table I. Key Organizational Actors at Statoil During the Notes Introduction

Abbreviation	Name	Agenda
E&P	Exploration and Production	Statoil's major division and key stakeholder, which, until 1995, included all exploration activities (of oil and gas) and the production of all offshore installations. E&P represented the major revenues of the company.
GEO-"scientists"		Experts (M.A.'s, Ph.D.'s) with an education and background in geology, petrophysics, and geophysics who rely on Unix-based systems for calculation and analysis
INF	Corporate Information or PR Department	Responsible for the spreading of official Statoil information both internally and externally. With the growth of the WWW and Statoil's Intranet, INF became a strong protagonist for WWW technology.
KIT	Corporate IS/IT Department	The department responsible for long-term strategic planning related to IS/IT issues in Statoil
KOT	Department of Co-ordination Technology at Statoil R&D	A multidisciplinary group of researchers who integrated organizational and IT development in a number of operational pilots at Statoil
SData	Statoil's internal IS/IT supplier	Statoil's chief supplier of operative IS/IT products and services. Through this role they have vital control over IS/IT issues at Statoil.

4. METHODOLOGICAL ISSUES

The methodology employed here is interpretive. Following Walsham's (1993, pp. 4–5) definition, we were "aiming at producing an understanding of the *context* of the information system, and the *processes* whereby the information system influences and is influenced by the context." The set of seven principles outlined by Klein and Myers (1999) for assessing interpretative field studies of our kind is instructive in making explicit our approach and reflecting upon its strengths and weaknesses. We discuss these principles by elaborating those most relevant to our study.

The first principle deals with the hermeneutic circle, that is, how our understanding of the whole is linked to our understanding of the parts, and the second principle deals with the historical background. In our study, we have combined these two in a manner that needs to be explained. We have worked out a historical

reconstruction of the whole process around the introduction of Lotus Notes in Statoil during the years 1992–1998. This approach is strongly motivated by the assessment by Mason *et al.* (1997, p. 258) that "MIS researchers, for the most part, have not sought to identify fully the broad socio-economic conditions of continuity and change that accompany the use of information technology." Rather than employing their phase-oriented "cascade" model of technical innovation, we lean heavily toward ANT-influenced analysis of sociotechnical mobilization processes as outlined in Section 2. This implies relaxing the notion of phases in innovation and allowing a wider spectrum of organizational actors. As a vehicle in this historical reconstruction, we developed a scheme where we added a number of categories with dated episodes and trends during the years 1992–1998. These categories are: external conditions, prevailing management strategies, major IT/IS projects, the rise and fall of key organizational actors, and important organizational development projects, in addition to the dates of important events in the technological solution directly connected to the establishment of the Notes-based infrastructure. By using the time dimension as the "anchor" it was possible to see how the development of the Notes infrastructure was connected to a number of other company efforts. For instance, the spirits of the time changed considerably during this period including Total Quality Management, ISO 9000, Business Process Reengineering, and knowledge management. Each of these gave the development of the Notes infrastructure support from different rhetorical sources. This overall map functioned as a navigating and sensitizing device for making sense of the smaller episodes in the hermeneutic circle.

The third principle is that of the interaction between the researchers and the subjects. Embedded in this principle is the critical reflection about how the data were socially constructed through the interaction between the researchers and the participants. Our access has been facilitated by our relation to Statoil. One of the authors (V.H.) has worked for Statoil for the last 7 years and worked with Notes implementation from 1994 to 1998 outside the official domain of SData. This has given him detailed information about the issues, people, data sources, and context under investigation. The fact that he has worked in a research unit (KOT) that several of the informers historically describe as a competitor to SData makes him biased. Still, it would be difficult for an outsider to develop the same depth of understanding.

We have dealt with this bias in two ways. First, the relation between the Statoil internal and the Statoil external (E.M.) author must be seen as dialogical, in the sense that the external author played the role of the "devil's advocate." This Statoil external author was granted an office space, an access badge, and a Lotus Notes account and spent on average 2 days a week at Statoil over a period of 5 months. Statoil has traditionally been relatively protective toward outsiders. The fact that the authors were free to wander about and make

appointments—symbolically gestured by the existence of a Statoil-based E-mail address—has greatly facilitated our ability to select and identify interesting sources of data rather than being closely steered. Second, since one of the authors knew the history as a direct participant in the setting, he might have unconsciously, based upon his preconceptions looked for data that supported his "prejudices." We tried to address this by seeking to validate our "findings" and discuss our account of the case with involved actors, and partly by relying on varied and independent sources of data that the external author collected and analyzed. Another principle we followed was that nothing from the internal author's memory or past field notes was used if it was not guaranteed by additional source material.

Digital data sources related to the issue under investigation were considerable (see Table II). There is an extensive electronic archive (Elark) which contains all official Statoil reports in addition to selected contracts, E-mail discussions, memos, and project documentation. There are also a large number of Lotus Notes discussion databases, newsletters, detailed project archives, budgets, and various forms of corporate presentations (slides, brochures, and folders). We have presented our findings at three meetings with major key organizational actors (SData, KOT, INF/KIT) with about 30 participants from several organizational actors including the research center, Exploration & Production and SData. Written reports have also been circulated and resulted in both E-mail and oral feedback. In addition to this, we have been engaged in participatory observation by taking part in project meetings, informal discussions, and coffee breaks. We have conducted 20 semi- and unstructured interviews lasting 1.5 to 2.5 hr (for more details and categorization of the information, see Table II).

The fourth principle deals with abstraction and generalization. This has been presented in Section 2, where we outlined our use of ANT and Douglas' work on order and categorization. The fifth principle is that of dialogical reasoning, which requires openness to potential contradictions between the dialogical preconceptions guiding the research design and the actual findings (the story the data tell) with subsequent cycles of revision. This is covered in our reflections above on principle 3. The sixth principle is that of multiple interpretations. We presented our interpretations to key organizational actors at meetings and on informal occasions during fieldwork. Most actors agreed with our interpretations, though less so for SData. To meet this ambiguity, parts of the story were rewritten to incorporate SData perspectives. In other instances, we backed our interpretations with more detailed data that could better support our interpretation. The seventh and final principle is that of suspicion. It requires sensitivity to possible biases and systematic distortions in the narrative collected from the participants. ANT gives a good framework to encourage critical thinking and reveal taken for granted assumptions (social facts). The digital material that was archived in Statoil's Notes databases provided "raw" material that could be interpreted as texts. Of special importance

Table II. Data Sources

Participant observation	First author	
	• Participated 2 days a week over a 5-month period • Given a Statoil badge (to walk freely) and access to Statoil's IT network	Discussions during coffee breaks and at informal meetings, mostly with KOT and other R&D-affiliated employees
	Second author	
	• A user of Lotus Notes since 1993 • Took part in implementation of Lotus Notes and Notes-related activities in E&P Units from 1994 to 1997 • Project manager of an important Notes implementation project in Norne (a new oil installation) in 1996	• Knew where to find the information resources • Knew key people involved in Lotus Notes implementation • Biased from the position of KOT
Digital data sources	Elark SData (Lotus Notes database)	Historic archive of SData with archived project files (the details of the digital E-mail-based communication in the project), reports, contracts, slide presentations, and strategies of IS/IT including the TeamIT newsletter
	Lotus Notes in E&P (Lotus Notes database)	Documents the E-mail communication related to each subimplementation of Lotus Notes in the period 1994–1996
	SData Bulletin Board (Lotus Notes database)	Internal newsletters from 1993 to 1998
	ESOP (KOT–KIT–SData) ongoing projects) (Lotus Notes database)	Nonarchived (or still ongoing) project databases of various important actors
	Private E-mail	Private E-mail messages sent during projects and handed to us as a consequence of interviews and discussions
	Intranet-based sources	Official project information of the Intranet related to IS/IT issues
	Internet-based sources	Official Statoil information at www.statoil.com
Other text-based data	Status (weekly leaflet and monthly newspaper)	Companywide internal newspaper reporting important news in all parts of Statoil
	Statoil Forum	An internal periodical devoted to strategy, organization, and management
	Ordinary newspapers	External Norwegian newspapers
Semi- and unstructured Interviews	20 interviews	
	• 3 members of the Notes project in 1994–1996	Key people in the implementation process (coded Intro1, Intro2, etc.)
	• 7 managers and decision makers in IS/IT	Key persons with a long historical knowledge of the subject matter (coded Manager1, Manager2, etc.)
	• 1 network manager	
	• 9 users	Users were above-average skilled professionals with regard to use of IT (coded User1, User2, etc.)

was the archived information from the electronic communication in Notes-related projects (see Table II). This information was of importance in validating the feedback of the informers.

5. ORDER AS UNIFORMITY (LATE 1980s–1993)

During its relative short history of existence, the revenues of Statoil have fluctuated considerably. This has created a shifting environment for how to conceive of the role and importance of IT. At the point just prior to the early establishment of a Lotus Notes-based communication infrastructure in 1992, Statoil experienced (relative) economic hardship. The post-Gulf War period after 1990 led to a recession in the oil industry, with falling oil prices and dollar exchange rates. At Statoil, the Exploration & Production Unit, the key contributor to company profits, painted a dark picture of the future.

The governing principles of the sequence of reorganizational efforts that were spawned in response to the sense of hardship identify "standardization of components and systems" together with the "use of vendor and industry standards . . . and a minimum of in-house development" (internal slide from a presentation of one of the reorganization projects). Hence, investment in IT was viewed largely as any other source of cost generation and hence a liable candidate for rationalizing and cost-cutting because at this time, around 1992, "IT was only considered an expense" (Introl).

The IT infrastructure at Statoil at this time was highly fragmented and diversified. There was no wide-area network accessible to PCs. In the early 1990s, there was a long discussion about LAN platforms in Statoil. There were in total seven LAN solutions including IBM's Token ring and an implementation of Ethernet by Novell (Manager2). In fact, in 1990 corporate IT had advocated Token ring as a corporate standard without achieving much impact. Similarly, there was a later decision to make LAN Manager OS/2 a common platform. What tilted the balance in the end toward a Novell-based Ethernet was that the core part of the IT department located at the corporate headquarter lobbied for this (Manager2).

The key mechanism for achieving a more cost-effective use of IT was through standardization of applications; it was "*the* thing to do" (Intro2). There was a widespread and general consensus about the need to standardize the existing jungle of office tools as "there existed more than ten different word processors at the time. . . . Everybody [out in the divisions] were [*sic*] happy that there would be only one tool . . . everybody applauded the decision" (Introl).

This lack of uniformity, this frustration with fragmentation, prompted a quick decision on a uniform office tool. The choice of the Lotus suite was made solely on price. Lotus, in a desperate move to carve a niche vis-à-vis Microsoft, made Statoil an offer they could not refuse.

6. ORDER THROUGH CENTRALIZATION (1993–1994)

The pressure outlined above to rationalize operations, increase efficiency, and cut back on costs was immediately translated into a centralization of the organization of the IT services. The argument for the centralization was economy of scale—or, in the language of earlier days—to "harvest the benefits of mainframes" (Manager1). In other words, the task of standardizing the technology by setting for Lotus was regarded as a symptom of the more general problem of a too decentralized decision and budgeting responsibility for IT investments (Manager1). Hence, the centralized SData (see the following paragraph) was expected to function as an arena for broad consensus for IT investments, a consensus unattainable before due to the decentralized organizational structure, because "without the centralization of SData, it would be impossible to reach decisions" (Manager1).

The subsequent centralization of IT that established Statoil Data (SData for short) in April 1993 was neither smooth nor straightforward. Beyond the turbulence within SData itself, the real issue was a fundamental reorientation of SData. The real challenge was to transform SData into a business- and market-oriented organization, to change from a "plan economy to a market economy" (Manager2).

SData needed to change substantially. They were vulnerable and had to reestablish trust with their biggest and most important customer, Exploration & Production. They were challenged by the newly formed group, KOT, dealing with communicative aspects of IT. SData was in bad need of an icon to symbolize the new era. SData worked hard to make Lotus Notes such a concerted effort. This fit well with the challenges identified in a 1994 strategy document by corporate IT:

> There is a low degree of integration between computer systems in Statoil, and the systems offer limited support for work processes that require information to be interchanged between the various functional areas and organizational units.

SData lobbied for Lotus Notes as a solution. For this to work, SData needed to establish an accompanying wide-area network as a communication platform.

The Lotus Notes infrastructure that SData attempted to establish was packaged together with two other components, namely, the standardized suite of office tools from Lotus and a PC-based, wide-area network that allowed the PC to communicate across the geographical locations of Statoil in and outside of Norway. This PC-based wide-area network was called I-net. I-net represented a massive investment for SData. In combination with Notes, I-net was—and still is—the gem of SData in the sense that it is a vital, corporate asset entirely under the control of SData. The control over I-net allows SData to act as a "gatekeeper" (Latour, 1987).

Hence, Notes was not introduced as a more or less isolated artifact; it was "bundled," packaged or aligned with existing and new elements such as I-net. The establishment of an information infrastructure always requires this kind of careful

alignment. This alignment functions as a confirmation of the order that is already in place. The prevailing order needs to be kept alive.

By the end of 1994, there were 10,390 Lotus users but only about 4000 Notes users (Notes newsletter, TeamIT 221294).

7. PRESERVING ORDER BY CURBING VARIETY (1994–1996)

The facade of Notes was undoubtedly E-mail, but in the background a more versatile use was prepared and encouraged, as "we had a clear policy about allowing the users to develop their own Notes applications" (Intro2). The Notes introduction project team lobbied hard to Exploration & Production, their most prominent customer, for a wider diffusion of Notes. Exploration & Production kept a short list of core systems for which they paid well. The Notes introduction was becoming increasingly important to SData, in commercial terms and even more so as a sign of acknowledgment. In a situation where SData was still working to acquire a sense of confidence, this was vital because "for SData, Lotus Notes was important, very important" (Intro2). After a series of rejections, in September 1994 Exploration & Production finally agreed to include Lotus Notes in their core portfolio of systems, thus financially securing the situation of SData.

SData was then able to turn to the vast number of small details that were needed to glue Notes together, to facilitate further spread. During this period from 1994 to 1996, the number of Lotus Notes users rose from about 4000 to about 14,000. SData focused on supporting the management of users, that is, the creation, deletion, and moving of users, changing the names and administration of the mailboxes. Filling in the gaps in the infrastructure, providing the invisible but necessary parts of the infrastructure, is a recurring pattern in the development of an infrastructure (Latour, 1996; Monteiro, 1998).

The mobilizing vision behind the Lotus Notes infrastructure at Statoil was to provide a smooth medium of communication where information could flow effortlessly. A taken-for-granted assumption, then, was a perfectly uniform medium of communication. More specifically, the Lotus Notes applications in Statoil were not tailor-made. SData instead promoted six standard applications including calender, meeting room reservation, and archiving. It was an ongoing effort by SData to keep the threatening fragmentation of Lotus Notes applications at a distance, which tailor-made Notes applications represented. An illustration of this is the attempt made by a member of one project within Exploration & Production to use a Notes application not among these six standard ones. Instead, he wanted to use a Notes application he knew about from colleagues working in a different project because

> given a few modifications, it satisfies our requirements. We accordingly wish to be allowed to develop such a non-standard tool. (E-mail to the Notes introduction team, archived in Elark 280995)

In their response to this inquiry, the SData Lotus Notes introduction team attempted to persuade them to reconsider using the relevant standard application, as otherwise "the project must cover the expenses of this adoption themselves" (E-mail 280995 archived in Elark).

The rapidly growing Lotus Notes infrastructure that emerged, which comprised also the Lotus office tools suite and the I-net PC network, had an administrative bias. The actual use of Notes to support communication and coordination during the early phases of oil production was very slow. The people involved here are geophysicists of various backgrounds (see Table I). The work consists of a variety of tasks including drilling, seismic exploration, analysis and visualization of drilling data, and simulations and modeling of the reservoir.

Given the nature of oil production, one might perhaps imagine that the competence of geoscientists was highly valued, that their requirements and needs were swiftly acted upon. This, however, is clearly not the case. The geoscientists are surprisingly low in the hierarchy and have more difficulties than one might expect in getting their voices heard. In the words of one of them, "It is the business students (Norwegian: *blårussen*) that govern" (User2). The largest union for geoscientists (Norwegian: *Norsk Sivilingeniør Forening*; NIF) has lobbied internally in Statoil to upgrade their esteem (Status newsletter, Status, 5 January 1992). Still, "[T]here are quite distinctly two ladders of carriers, one for geo-scientists and one for management" (Manager5). Without exaggerating the level of conflict, a NIF union leader still points out the "intrinsic conflict of interests between the geo-scientists and management" (User9).

In relation to the emerging and prevailing sense of an orderly Notes infrastructure, the geoscientists' applications, work routines, and competence simply did not fit within the constructed categories. The tools and applications needed to support their work have, throughout the 1990s, been Unix. To perform their work, these Unix-based tools are essential. Even today, "it is unthinkable" to migrate these tools to PC due to performance considerations (User1). The current ratio of Unix users to PC users at Statoil is about 1:15.

The introduction of the Lotus suite and later Notes was made smooth by "promising that Unix clients would also be available" (Manager3). Hence, early in 1994 a small group of SData people was to explore the possibilities of finding or developing a Unix emulator because "in Statoil there is a pressing need to run PC applications from Unix work stations" (Notes introduction newsletter, TeamIT 280194). Only later did it become clear that these promises would never be kept, that Lotus simply was not going to develop Unix versions.

The analysis, simulation, and modeling based on the drilling data take place in project teams. All the drilling data for all the oil fields of Statoil originate from a Unix-based database which has been revised and upgraded a number of times during the last 10–15 years. Statoil's competitive edge is closely linked to its ability to exploit and continue to refine this database. The tools extract data

from the database but these tables, graphics, and models then "have to be exported from Unix" for further elaboration into reports, slide presentations, and archives (User4). The tools for producing this documentation are not Unix based but PC based, implying that everything has to be moved across the two platforms using file transfer services. This moving around of data is not always as smooth as it is supposed to be, as "it is a lot of fuss with Postscript files, they cannot be read on a PC when exported from Unix" (User4). This prompts an extensive repertoire of work-arounds to cope with these problems. Some keep a bag of tricks that they have accumulated. To illustrate, a file "washing" program was picked up by one engineer from a friend and colleague working for another oil company, Norsk Hydro; another asks favors from people he knows in the graphics group, and yet others use "the people I know" (User1).

8. DEFENDING ORDER BY FIGHTING OPPOSITION (1996–1997)

In a number of ways, the pressure for opening up and orienting Statoil more toward the outside world was building up from the mid 1990s. This came about partly due to fairly general trends such as the rapid folklorization of Internet and Web in the media. In addition, the oil industry underwent important restructuring during the period 1995–1997. There was a growing awareness of the need to communicate with external partners and subcontractors.

In terms of technological infrastructure, the situation in Statoil was still characterized by fragmentation by multiple communication standards and platforms (Internal Statil report: Statoil's integrated network in year 2000, April 1997, pp. 35–37). There was a FDDI fiber-optical network at the corporate headquarters. Between major sites, a number of wide-area network solutions were used, including leased lines, ISDN, Frame relay, and ATM. Communication with Statoil sites outside the Norwegian main land was by Frame relay or satellite. LAN communication was dominated by 10- or 100-Mbps Ethernet running Novell IPX, TCP/IP, and some Apple talk. Token ring segments still existed at some locations.

With regard to the evolving Notes infrastructure, the overarching trends were translated into a simple question: Was Notes an appropriate infrastructure to meet these challenges? There was at this time no obvious way to align the new requirements concerning opening up to the outside world with the existing Notes infrastructure.

The strategy used by SData was one of marginalization. The proponents and arguments behind, for instance, internet and Web were attempted to be sidelined by presenting them as misguided. Hence, the proponents of Notes tended to downplay the significance and substance of the objections to Notes because "the advocates of Internet are those who do not know how good Notes is with regards to Internet" (Intro1). The heart of the problem, the accusation that Notes

was a closed system and hence inappropriate when Statoil was to open up to the world, evaporated with Lotus' Domino servers capable of gatewaying between Notes and Web. It was accordingly presented as a "misunderstanding" that Notes was closed, as "Notes has tools for SQL queries together with the new Domino servers" (Intro1). And as a consequence, "the controversy have died out" (Intro2).

Statoil has traditionally been fairly closed to the outside world. Unix users have had access to E-mail communication with external partners from the early 1990s. Memo, the corporatewide E-mail system introduced at Statoil in the 1980s, was only for internal communication. With the establishment of an X.400 E-mail gateway, Memo and Notes mail was able to be used for external communication from 1995. In 1996, a Notes-based simple mail transfer protocol (SMTP) server made Internet mail available directly from Notes. Non-E-mail communication with the outside world, however, arrived rather late at Statoil, that is, for PC users. Unix users had access to a broad range of services such as archie, ftp, telnet, and Web. Web was for this reason shrugged off as "a Unix thing." PC-based Web browsers were allowed only from late 1995, and only in response to a formal application. Only in January 1998 was it allowed to browse from a PC without special permission.

9. ANALYSIS: ESTABLISHING AND MAINTAINING ORDER

9.1. The Self-Evident Character of Order

The most fundamental shared insight provided by (among others) the discursive analysis of Foucault (1970), Douglas' (1966) analysis of the socially constructed categories underpinning our sense of order and purity and ANT (Bowker and Star, 1994; Latour, 1996; Law, 1991), is that although we take our notions, beliefs, and knowledge very much for granted, they are contingent. But this contingency is not apparent, hence it requires an effort to unpack. In relation to images of order in an information infrastructure, it is striking how seemingly self-evident this is. It is common wisdom that collections of information systems in general and an information infrastructure in particular need to be tidy, well defined, and with clean interfaces to surrounding services and modules (Gardner, 1998; Weill and Broadbent, 1998). When the Lotus suite of office tools was introduced at Statoil, it was simply so obvious that order in the form of "standardization" was the answer that critical remarks appeared laughable. There are, of course, a number of good reasons to strive for this form of order in an information infrastructure: it could make it more transparent and easier to grasp, simplify maintenance and further development, and so forth. Empirical evidence (Ciborra, 1996; Hanseth *et al.*, 1996), on the other hand, strongly suggests that this level of order and stability is unattainable—it is a beautiful dream—and probably neither

functional nor cost-effective (Berg, 1997; Hanseth and Monteiro, 1997; Williams, 1997).

Hence, we want to pose the following set of questions: *How* was it that order was constructed at Statoil in the form of a standardized Notes solution? *How* is it that it is possible to mobilize such a strong support for avoiding fragmentation of the information infrastructure? What are the mechanisms at play which produce such an effect? and How does order become socially constructed as self-evident? There are, as we see it, several sources, which we discuss in turn.

Clearly, the image of tidying up, for instance, the "jungle of office tools" (User1), acted as a forceful organizing vision in the sense of bringing the community of users together and developing a sense of shared purpose and destiny (Swanson and Ramiller, 1997, pp. 460–461). The economic hardship portrayed at Statoil in the early 1990s also had a strong disciplinary effect. Hence, when the request cited in Section 7 to customize a Notes application was answered by insisting that they then had to bear the full costs themselves, this was a fairly effective way of saying no.

What took place, then, was that one and the same problem was addressed from three different angles: cutting costs (external pressure), which led to curbing the IT mess (the technical side), which subsequently led to centralizing the IT department (the organizational aspect). This trinity of cost-cutting, tidy technology, and centralized organization was extremely strong: so strong, in fact, that no opposition was voiced. The three of them were mutually reinforcing, or in ANT vocabulary, they were aligned to form a stabilized network.

In the work of Douglas (1966), there is no question why efforts of tidying up touch upon such deep feelings: preserving a sense of our order is intrinsically linked to how we make sense of our (from the outset chaotic) everyday world. Avoiding chaos in this way is a basic human instinct according to Douglas. Hence, we have to turn to ways in which order is performed. Mundane everyday rituals play an important role in reestablishing and reconfirming the prevailing order. They keep it alive and vivid. Examples of such rituals in our case are project meetings at SData discussing the further development of Notes, the launching of campaigns for disciplining the use of E-mail, and the upgrading to newer versions of Notes and I-net. These rituals functioned as a stabilizing principle, as they naturalized order and classification (Douglas, 1986).

Other scholars have argued that there is a strong rhetorical device at work which explains why organizational members develop taken-for-granted beliefs (Meyer and Rowan, 1977). These beliefs function as myths and exercise a strong influence. Alvesson (1993) echoes this and suggests that organizations cultivate symbols to construct positive images of themselves. At Statoil, it is reasonable to read SData's commitment around 1993–1994 to Lotus Notes as, at least in part, an expression of their attempt to construct a more fast-moving, responsive image of themselves vis-à-vis KOT.

9.2. Order Is Never Neutral

Moving forward from the analysis above about how the given order cast as a standardization regime was constructed as "obvious" or "natural, let us now turn to the implications. Actor–network theory, as Outlined in section 2, instructs us that no given order is neutral. It "embodies and inscribes work" by privileging one way of working on behalf of another (Bowker and Star, 1994, p. 187), it makes one set of organizational actors more visible and influential on behalf of others, and it acknowledges one kind of knowledge and practical abilities over others. This is, of course, the reason that an analysis of the social construction of order in an information infrastructure is interesting. Merely to document that order is not given is neither original nor too difficult. This is but a stepping stone to analyze the implications of a given order and, to reiterate Foucault (1970, p. xx), that it is "perhaps not the only possible [one] or the best [one]." What, then, were the implications at Statoil of constructing an orderly infrastructure as a nonfragmented Lotus Notes-based one? What kind of work routines had to be augmented and needed work-arounds to fit (Gasser, 1986)? Who became invisible? and What type of work and knowledge was less valued?

We suggest that the geoscientists are a case in point. Their existing information infrastructure was downplayed, their work had to be extended with a rich set of work-arounds, and their knowledge and professional expertise were challenged. We have already illustrated the former two, namely, how the Unix-based infrastructure of the engineers was poorly supported and how the fragmentation across the Unix/Notes border spawned a set of work-arounds. To illustrate the latter, how their knowledge and expertise were challenged, consider the controversy over the interpretation of drilling data.

Generating, analyzing, and interpreting the drilling data is, of course, central to the operations of an oil company such as Statoil. There was continuous negotiation over who is to be in charge of this operation. The controversy circled around who should rightly perform this task and what kind of skills were required to do it. In short, the geoscientists argued that their competence was needed to make sense of the data, that the data could not be interpreted out of context or by persons without a sufficient technical background. Management, on the other hand, argued that what was needed was assessment, prioritization, and decisions that cut across the details of the single drilling, in other words, that the geoscientists focused too much on the details and forgot the larger picture. This negotiation over the influence and gatekeeping function over a key activity for Statoil unfolded largely as a controversy over technology as illustrated below.

The core database, Sphinx, which contained all Statoil's drilling data, was an old database which had been migrated and revised on several occasions: from an IBM platform to Unix, from a text-based interface to X-windows, from X-windows to Motif. The historical heritage of oil production was inscribed into its core in

important ways. In the early years of Norwegian oil production, during the 1960s and early 1970s, there was a massive import of United States-based oil competence, workers, and technology. This is, in numerous ways, evident even today. Sphinx was an example of this import. The core of Sphinx, its organizing principle, that is, its indexing, inscribed the traditional way oil searching and production were done: by drilling strictly vertical, land-based holes (Bowker, 1994). This implied that, for every hole, the length uniquely identified a location. This inscription had been challenged by the searching on the Norwegian, sea-based shelf. Over the past years, the ability to steer the drilling sideways, even upward, undermined this design assumption inscribed into Sphinx. It implied, among other things, that there could be two locations at the same vertical depth. This reinforced the need to make sense of the data in Sphinx, as "it is important to be technically skilled when interpreting the data" (User4). This skill was supplemented by the exploitation of the tightly knit informal network which existed among the different clans of geoscientists. Whenever there were problems in interpreting the data, "I call the people I know" (User1) or they consulted their own private copies and note pads from earlier projects (User4). Accordingly, the data in Sphinx were but the espoused version of the interpretations that need to be supplemented by locally informed insights, as "I hang on to my local copies as well" (User 4). Hence, the way the documents were collectively produced left a much richer material than what got "dumped into the electronic [Notes] archive" in the end (User4). This gave rise to the forceful myth about the poor data quality of Sphinx, namely, that it was basically sloppiness by the geoscientists that accounted for the difficulties in extracting and interpreting data from Sphinx (Garfinkel, 1967).

9.3. Fighting Over the Construction of Order

There were moments when the very construction of order was challenged and the seemingly "natural" order was questioned. When it no longer was obvious, how was the prevailing order defended and how was opposition met? In addressing this, we analyze the controversy which surfaced around Web in 1995–1996.

The threat to the Notes infrastructure from Web was quite real. What the outcome would have been had Statoil not been saved by the bell through the introduction of the Lotus Domino servers which acted as Notes/Web gateways was uncertain:

> Had not Lotus introduced their Domino servers, I think it would have been difficult to defend Notes [against Web proponents]. (Manager1)

Internet had been of marginal importance to the company up till this point in time. Unix-based specialists and a few people at the research center or SData had used it regularly since 1993. But the general potential of this new phenomenon was

first realized via the media from late 1995, increasing steadily in 1996 with the folklorization of Internet. With this, a general change in spirit occurred, focusing on IT as an enabler.

The mobilization of Web as an alternative to Notes was not merely in the form of "pure" technology. Also, organizational actors moved to enroll the Web as an allie. The media and information unit (INF) were especially active here. As they were delegated the new responsibility of Web editing, they felt a special need to become visible. As is the case in many places, the most enthusiastic proponents of Web are initially found outside the traditional IT department. In a memo outlining a new project, a project leader in the media and information unit described the situation as follows:

> Information sharing in Statoil will gradually shift from the basically Notes based reality of today to a Web based system. (Internal report: Information sharing in Statoil, 121297, p. 5)

There were—and still are—distinct and conflicting views about whether Domino represented a sufficient strategy to address the requirements on openness, as "many are still very skeptical to whether Domino is sufficient" (Manager1).

Having worked hard for the emerging Notes-based infrastructure for more than 4 years, SData had invested a substantial amount of sweat and prestige into it. The Notes infrastructure had, to use ANT (Callon, 1991; Hanseth and Monteiro, 1996), acquired a certain irreversibility. It had become difficult to undo it, as Douglas (1966, p. 36) explains, because "as time goes on . . . we make a greater and greater investment into our system . . . [and] uncomfortable facts which refuse to be fitted in, we find ourselves ignoring or distorting so that they do not disturb these established assumptions."

Given this inertia (Bowker and Star, 1999; Star and Ruhlender, 1996; Hanseth *et al.*, 1996), what kind of strategy did SData (unintentionally, most likely) pursue? Again, Douglas' analysis of purity contains the essential insight. To mobilize support for the orderly, standardized Notes solution, all you have to do is to construct your opponent as "dirty" because "a polluting person is always in the wrong . . . [and] unleashes danger for someone" (Douglas, 1966, p. 113). We argue that this is exactly the (unintentional) strategy SData pursued when they forcefully argued that the existing Lotus Notes solution represented order, hence purity, and that the introduction of Web represented fragmentation, hence dirt, because

> We risk that the company's information and access get fragmented. . . . The Intranet market is highly fragmented today, with a number of strong competitors fighting each other with technological as well as political means. . . . For the non-specialist, this creates the impression that Intranet technology is cheap, but it is of key importance to recognize that the Intranet technology of today has it price—they require an effort to be integrated with the existing infrastructure of the company. (SData strategy document: IT challenges and trends 1996–1999)

This strategy of describing the alleged dangers of fragmentation was quite explicit. The citation above from a strategy document was made productive by circulating and emphasizing it in subsequent E-mail discussions (E-mail archived in Elark, 031296). This echoes Douglas' analysis of the dangers of giving sacred objects (here, Notes) a profane status. Hence, any attack on the sacred will evoke strong reactions to defend it.

Still, the present situation (2000) is characterized by a certain stability in the Domino-based compromise. This, interestingly enough, is sustained by the increasing invisibility of the original Lotus Notes infrastructure. With the widespread use of Web browsers, the majority of users need not (and, indeed, do not) know whether or not the information originated from Notes databases.

10. CONCLUSION

The basic moral of social constructivism is one of caution. Taken-for-granted beliefs, technological solutions, and sense of order are not "given"; there is a process of naturalization that *produces* this effect. In this sense, our study has reiterated an old moral. Still, we believe that the challenges with information infrastructure require a grasp beyond the programmatic stipulation that they are "socially constructed." For users, policymakers, managers, designers, and researchers it is of vital importance and relevance to dig deeper into *how* this construction unfolds. Our study aims at contributing to one—neglected but essential—aspect of this process, namely, the symbolic, social, and technical mechanisms at play in constructing an orderly information infrastructure. This is difficult to get at due to the deep-seated nature of our sense of order. Still, there is no way around a critical assessment of order when establishing a working information infrastructure; it is cumbersome but necessary.

We have demonstrated how the taken-for-granted sense of order in the establishment of a working information infrastructure at Statoil—standard Notes applications, standardization on Lotus products, standard communication protocols—was in fact not obvious; it got constructed as obvious. The way this hampered alternative design and created work-arounds for some of the actors at Statoil strongly suggests that designers, managers, and users alike need to assess critically "obvious" assumptions about what constitutes an orderly infrastructure.

ACKNOWLEDGMENTS

We are grateful for the support and constructive criticism through our participation in the InfraGlob project led by C. Ciborra together with K. Braa, A. Cordella, B. Dahlbom, O. Hanseth, J. Ljungberg and K. Simon. The numerous comments and objections from Statoil employees were essential. We also benefited from comments from O. Ngwenyama and D. Greenwood. Elements of this work were

presented and discussed at the workshop Cultural Politics of Technology, Information Systems Research in Scandinavia, and working conference IFIP WG 8.2 and 8.6. This work was partly sponsored by the Norwegian Research Council's program on social aspects of information infrastructure (SKIKT).

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