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SAP[1] as Emergent Infrastructure in a Global Organization[2]

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ABSTRACT

This article presents and discusses globalization and IT infrastructure development and use in the European fertilizer division of Norsk Hydro. The main element of the infrastructure discussed is a new SAP based solution for this division. However, this solution is not an isolated artefact. Its important aspects are emerging, as it is becoming an integrated part of a larger infrastructure.

An SAP installation in a global organization becomes a large and complex infrastructure. Just as much as this infrastructure is designed and controlled by managers and IT personnel, it becomes an actor shaping its environment as well as its own future. Like any actor, the technology builds alliances with others. However, the alliances might change over time. In the case reported here, SAP first got allied with top management, playing the role as a powerful change agent. Later on, however, SAP got allied with local managers and users, helping them bring the change process under their influence and into the speed they preferred. Currently, SAP is changing its role as it gets installed and integrated into a larger corporate infrastructure. As such, it becomes everybody's enemy by resisting all organizational change.

Key-words: Emergent process, Infrastructure, Actor-network.

(1) More precisely the article addresses the emergence of an IT infrastructure in which SAP R/3 installations are important elements. Just for convenience, we denote this an SAP infrastructure.

(2) An earlier version of this article was presented at and published in the proceedings from ICIS '98 in Helsinki.

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RÉSUMÉ

Cet article présente la globalisation ainsi que la mise au point et l'utilisation de l'infrastructure IT au sein de la division européenne des engrais chez Norsk Hydro. L'élément principal de l'infrastructure en question est une nouvelle solution pour cette division qui est basée sur SAP. Pourtant, cette solution n'existe pas toute seule. Ses aspects importants se révèlent à mesure qu'elle devient une partie intégrante d'une plus grande infrastructure.

Une installation SAP au sein d'une organisation globale devient une infrastructure grande et complexe. Non seulement cette infrastructure est conçue et contrôlée par des gestionnaires et le personnel IT, mais elle devient aussi actrice façonnant son environnement ainsi que son propre avenir. Comme tout acteur, la technologie construit des alliances avec d'autres. Cependant, les alliances peuvent changer avec le temps. Dans le cas présenté ici, SAP s'est allié d'abord avec le management de haut niveau, jouant le rôle d'un puissant agent du changement. Plus tard, SAP s'est allié aux gestionnaires locaux et aux utilisateurs, les aidant à ramener le processus de changement sous leur influence et à la vitesse qu'ils préféraient. Actuellement, SAP change de rôle à mesure qu'il s'installe et s'intègre à la plus grande infrastructure de la société. En tant que tel, il devient l'ennemi de tout le monde en résistant à tout changement organisationnel.

Mots-clés: Processus émergent, Infrastructure, Acteur réseau.

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1. INTRODUCTION

This article presents and discusses globalization and IT infrastructure development and use in Norsk Hydro, and in particular the European fertilizer division, called Hydro Agri Europe (HAE). The main element of the infrastructure discussed is a new SAP based solution for this division. However, this solution is not an isolated artefact. Its important aspects are emerging as it is becoming an integrated part of a larger corporate infrastructure which again is linked up with other infrastructures (in other corporations, the Internet, etc.)

The notion of infrastructure has become popular in the information systems community in later years. However, infrastructures seem to be assumed similar to information systems, i.e. as completely designed and controlled by humans (Broadbent and Weill, 1997; Broadbent, Weill, and St. Clair, 1995). We will in this article draw on two theories going beyond this view on technology – the "economics of infrastructures and standards" and in particular actor-network theory.

The case of large infrastructures reminds us that the management of infrastructure goes beyond the boundaries of centralized, hierarchical control of a resource. Infrastructures differ from "systems" in being a shared resource for a larger community rather than an organizational unit. Further, one infrastructure builds upon and is integrated with others into networks with no limits. As such, infrastructures cannot be designed and managed according to principles of (isolated, stand-alone) information systems. They are developed and changed by several independent actors without any explicit co-ordination. The main co-ordinator (or co-ordination mechanism) is often the shared infrastructure itself. Further, large infrastructures cannot be changed instantly – only piecewise. At the same time as it is subject to such a change process, it has to work as usual. This requirement severely constrains the design of the new elements, implying that the existing infrastructure – the installed base - has strong influence on the future development of the infrastructure (Grindley 1995, Hanseth 1996). While resisting change and having reached a certain level of distribution and use, it gains momentum and drives its own further growth (Hughes 1987). It becomes an actor, and a designer.

Some infrastructures might appear "designed". Taking the Internet as an example, one might consider it designed because the protocol standards are. However, whether the protocols are designed in a traditional sense can be debated, as illustrated by the struggling behind the new version of IP (Hanseth et al. 1996, Monteiro 1998). Looking at the physical network, its structure is highly *emergent* (Ngwenyama, 1998), being built by a vast range of operators and companies linking their networks to the existing Internet. Looking at how information is made available and the way it is structured, one will see an even more uncoordinated process. Also corporate infrastructures are often emergent as they are typically established through side effects of and spillover from the implementation of increasing numbers of information systems

as well as their closer integration. Through such processes, a complex infrastructure emerges and the information systems become less independent.

When infrastructures grow and their use increases, they indeed become large and irreversible actor-networks. Within management and engineering literature, technology is primarily seen as something to be designed, i.e. as completely controlled by and a product of human activity. In other literatures, more focused on macro level processes, the usual story is how technology changes the world – often portrayed as revolutions. More than any other technology IT is seen as such a revolutionary force. In these stories technology is the master – or designer – and society its material being "designed". We will apply actor network theory which is an approach explaining how humans are shaping technology (under some constraints – of course) at the same time as technology influences the development of society beyond what was intended by the designers without completely determining its path (Callon 1991; Latour 1987, 1991).

Actor-network theory is chosen because it has been developed to help understand the borderlines between technological elements on the one hand and human, social, and organizational (i.e. non-technological) on the other. For this reason we find it more relevant for our purpose than, say, Giddens' structuration theory. The latter has proven to be a fruitful and popular vehicle for interpreting IS implementation and use. But its lack of attention to technology makes it less attractive. For these reasons actor-network theory has become popular also in the IS research community (see for instance Bloomfield et al. 1997, Walsham 1997, Walsham and Sahay 1999, Monteiro and Hanseth 1995, Hanseth and Monteiro 1997).

In actor-network theory, technological and social elements are considered tied together into networks, based on the assumption that technologies are always defined to work in an environment including non-technological elements – without which the technology would be meaningless and it would not work. In the same way, humans use non-human objects (technologies and other artefacts) in all our dealings in our world – our existence in the world is based upon the existence of these objects. Accordingly, neither humans nor technological artefacts should be considered as pure, isolated elements, but rather as *heterogeneous networks*. When any actor acts, this very actor is always such a network, not a single element. In the same way, elements in a network are not defined only by their "internal" aspects, but rather by their relationships to other elements, i.e. as a network. This further implies that elements in such a network are not initially defined as human, social, or technological, they are referred to by a common term – actant. These assumptions do not deny any differences – or borders – between what is human or social and what is technological. However, these borders are seen as negotiated, not as given.

According to actor network theory, stability, technological and social order, are continually negotiated as a social process of aligning interests. As actors from the out-

set have a diverse set of interests, stability rests crucially on the ability to *translate* (re-interpret, represent or appropriate) others' interests to one's own. Through translations one and the same interest or anticipation may be presented in different ways thereby mobilizing broader support. A translation presupposes a medium or a "material into which it is inscribed". Translations are "embodied in texts, machines, bodily skills [which] become their support, their more or less faithful executive" (Callon 1991, p. 143). Design is then a process where various interests are translated into technological solutions as well as organizational arrangements and procedures to be followed to make the technology work properly. In this process, existing technology will be re-interpreted and translated into new ways of using it. To make the technology work, all these elements must be aligned. As large actor-networks are aligned, they may become irreversible, and hard to change (Callon 1991, Hanseth and Monteiro 1997).

The case study reported here is one of six carried out in parallel, all studying the dynamics of IT infrastructures in global organizations (Ciborra et al. 2000). The case study is conducted according to the principles of interpretive research as outlined by Klein and Myers (1999). The empirical material is collected through approximately 25 interviews from two to five hours, about 15 follow up conversations and shorter interviews using telephone, and a number of internal documents and memos. Hydro sites in Norway, USA, and Italy have been visited.

2. GLOBALIZATION AND IT INFRASTRUCTURE IN NORSK HYDRO

Norsk Hydro (NH) is a diversified Norwegian company, founded in 1905. Since 1972 its income has grown from 1 to 96 billion NOK. Besides its original fertilizer business, it produces light metals, oil and gas. The business divisions have enjoyed a high level of autonomy. Independent IT strategies and solutions have been the common practice. Since the late 80's the main goals of corporate IT have been: unified solutions to avoid duplication of efforts among the divisions, infrastructure standards, and sharing competence in systems development.

Institutions for building consensus were created to achieve these goals. Consensus was reached about the need for a common protocol (TCP/IP), and a corporate standard, called Hydro Bridge, for desktop and communications applications. Today, there are about 20,000 Bridge users. Over the years, however, with the proliferation of systems and applications (Windows, new operating systems, networks etc.), the Bridge has grown to become an umbrella standard and infrastructure, losing its initial focus on desktop applications. It includes Hydro's global network as well as a wide range of applications. Several functions are duplicated (Lotus and Microsoft desktop products, Notes mail and cc:mail, Notes databases and Web, etc.). Throughout the 90's collaboration and knowledge sharing between divisions as well as with outside organizations (like engineering companies in the oil sector) have been increasingly focused. Lotus Notes and the rest of Bridge are seen as

important tools supporting this. Notes use has been supported by the development of an infrastructure of more than one hundred servers. Beyond that diffusion has been based on local user initiatives. After a slow start, Notes use gained momentum. About 1500 applications are in operation.

Currently Hydro is building a considerable corporate SAP infrastructure. The overall approach has been bottom-up as decisions are distributed to the individual divisions. (The approach followed by the individual projects, however, is usually top-down.) Thus, the overall infrastructure is emergent rather than deliberately planned and designed. The first SAP applications were installed in France in 1990. SAP was settled as corporate standard in 1994. The decision was based on cost considerations. Having one license for all divisions was cheaper than if the divisions where buying different systems or even buying SAP individually. At that time – and still – SAP applications are seen as separate, individual information systems, and *not* as an infrastructure, or even as parts of any infrastructure. The divisions decide completely on their own how to implement and use SAP. (They are also allowed to choose another system. If so, however, the decision has to be made by top division management.)

Hydro Agri Europe (HAE) is the largest division and is the owner of the most ambitious SAP project. HAE includes 19 production sites and in total 72 sites throughout Europe. Since the 80's Hydro has bought several fertilizer companies all over Europe.

In line with traditional Hydro-management policy, the companies bought were run "hands off" (i.e. as independent as possible). Most of the companies were only selling within national markets. The exceptions were the two largest factories, the ones in Norway and the Netherlands. (The Norwegian company was exporting 95% of its total production.) In 1992 the prices were very low bringing the whole division into a crisis. The individual companies started to expand out of their traditional markets to increase their income. This implied moving across national borders, starting to compete with other Hydro companies. In this situation the division management decided that the operations in Europe should be integrated into one unit.

A very ambitious re-engineering project started. Its most important objectives were: reengineering into one profit centre ("synergy between processes through global organizing"), customer focus and a powerful market organization, and establishing common work processes supporting this.

When the re-engineering started, HAE had a strongly introvert engineering culture. Customer focus as well as change management were unknown or considered irrelevant issues. The change plans also raised very strong resistance. This resistance could be observed at all levels in the organization, not the least at top management in the different (national) companies.

A re-engineering project of this kind was also a brand new task for the division management (as it would be for any manager). The organization to be re-engineered consisted of a large number of independent units spread across most European countries. The or-

ganization was very young, no shared culture or identity existed. Change in this kind of multi-cultural organization was new for Hydro. The change process was made even more complex by the fact that in parallel with the integration the division should be organized according to a "process model" (the latest fashion at that time).

Soon after the integration decision was made, a group working on central production planning was established. The rest of the change was tried and implemented through "change agents working from the middle". That meant people working full time on the change, without, however, being in positions were they could make any decisions. As a result, they were "frequently shown the door" when visiting local offices and factories.

What the envisioned changes required was grossly underestimated. Local managers and virtually all the employees did not see the need for integration. They focused on caring for their territories. Thus, no change took place.

In parallel with the integration activities in Europe, Hydro has set up or bought new factories and sales offices outside Europe (partly through joint ventures). Closer Cupertino between the European division and other units is considered continuously more important. (A significant part of the fertilizer produced in Europe is sold in other parts of the world.)

Hydro is rapidly globalizing. The strategy is expansion through acquisitions and "organic" growth on one side and increased integration on the other.

3. SAP AS ACTOR

We will now look closer at the role SAP played in the change process.

3.1. SAP

SAP (Systeme, Anwendungen, Produkte in der Datenverarbeitung or, in English – Systems, Applications and Products in Data Processing) is the leading global provider of client/server business application solutions, or so-called Enterprise Resource Packages (ERR). SAP markets two primary products: R/2 (mainframe) and R/3 (client/server). Both share many features and provide similar functionality via an integrated suite of software application modules. SAP client/server and mainframe business applications handle comprehensive financial, manufacturing, sales and distribution, and human resources functions essential to the operations of a business organization. There exist more than 15,000 installations in over 85 countries. SAP's client/server suite alone has been installed in more than 7,500 companies worldwide.

It is reported that SAP R/3 works particularly well for companies that have a strong top-down organization or that are structured in the same way as R/3 is structured. When this is not the case, the system must be modified through the system configuration channels or via track-on modules written by external vendors or the companies' systems programmers. These modifications can cause major upgrade problems (Bancroft et al. 1998). Such upgrade problem have been experienced in the Oil & Gas division finding that maintenance like mo-

ving from one version to another is very expensive and comprehensive. R/3 is experienced as a quite unfinished system; thus corrections arrive continuously as service packages. Because of local adaptations thousands of parameters have to be configured. Experience from SAP implementations tells that allowing a company's divisions to benefit from operating in unique ways makes it difficult or impossible to accommodate using a shared R/3 implementation (ibid.).

In spite of the fact that viewing SAP installations as isolated information systems seems to be shared by virtually everybody in Hydro, we believe, and will show in this article, that it would be beneficial to consider SAP in Hydro an information infrastructure. The reason for this is, first, that some of the installations are becoming so large in themselves that they are getting the character of an infrastructure. This is the case for the SAP installation in HAE. Second, each individual installation is becoming integrated with other SAP installations as well as other systems and infrastructures, in particular the Bridge infrastructure. SAP in Hydro is a large and complex *emergent* infrastructure, and definitely not a designed one.

3.2. From re-engineering to SAP implementation

When the re-engineering started, IT management soon reached the conclusion that the division could not be integrated on the basis of a heterogeneous collection of computer equipment and information systems used throughout the division. Every company had its own portfolio of applications. Their basic infrastructure in terms of computers, operating systems, data base management systems, and communication networks were delivered from different vendors. Virtually any available technology was in use somewhere. In January '94 HAE launched a new IT strategy project. This project concluded that the whole division should go for an ERP package, and that this package should be SAP. Based on this package, one set of applications should be common for all units. In August 1994 this conclusion was turned into a decision by top division management. The SAP project started in early 1995, and was planned to be finished by mid '99.

The project was split into four teams. Three of them were working on requirement specifications and the organizational implementation of SAP in the areas of marketing, finance, and production respectively. The fourth team was responsible for the IT development work. Further, the project activities were split into three phases:

1. Development of a pilot and implementing it in one factory and one sales office in Germany.

2. Validation of the pilot. This comprised:

- 3 months with extensive production support to make the pilot work properly,
- validating the pilot in terms of a gap analysis specifying required changes and extensions for other units, and finally,
- developing the "final" version.

3. Implementing the final version in the whole division.

When the validation started, five regional project teams were set up to take care of this. The project

covering the Scandinavian plants and offices had more than 100 members.

The validation identified more than 1000 "issues", each of them requiring changes in the system. In total this meant that the design and implementation of the "final" version required much more work than expected. Some also argued that the "final" version should be based on a complete redesign of the pilot as it was not structured as well as the more complex final version would require. This did not happen.

The attitudes to the SAP project varied between units in the organization, and it changed over time. As the decision about organizational integration as well as SAP implementation was made without any involvement, people were very sceptical about SAP in the early phase. But during the validation this scepticism turned into enthusiasm. In this phase people got more hands on experience, they saw new possibilities opened by the new technology combined with the new organizational structure, and they felt they were heard. On the other hand, this involvement and experience also created great expectations. When the implementation was progressing much slower than planned, the enthusiasm turned into disappointment.

The SAP implementation created different reactions among different units and different personnel groups. In Italy, for instance, there was no resistance. They were dissatisfied with their original solutions, and expected changes, as they were just enrolled into Hydro. In most countries, however, the market people were afraid of losing their freedom and the administration people were afraid of losing their jobs. The market organization has defended their current positions and ways of working by arguing that they are the business people knowing what the customers need and what they should do to best serve these needs.

During 1998, the teams also have been struggling to keep the project moving due to its complexity, the young age of the organization, and the huge cultural differences. Among key members it is also held that major difficulties were due to lack of understanding of what this is all about – it was not "just another IT project". On the other hand, people felt exhausted and wanted to finish the SAP project, so there is little resistance left.

When the SAP project started, the original re-engineering project was subsumed into it. The original objectives from the re-engineering project were, however, still alive – now expressed as "One single integrated European learning organization". As a result of the slow progress, there was a change in top management in the division, followed by a change of all national marketing managers.

The focus of the re-engineering work is on establishing "common processes" across the whole organization. When these are in place they are assumed to serve as a platform for closer integration. The changes are most significant in "front" (i.e. sales) offices. The sales personnel are going to sell all products manufactured by the division, not only those provided by the local plant. In addition, they are supposed to be "empowered" by the new systems, and accordingly capable of working more

independently. This is leading to a lesser need for middle and office managers and giving them a new role where "developing people – not controlling" is what it is all about.

The project has considerable attention and support from top corporate management. "Our progress in these areas is moving ahead as planned, but it costs money", the CEO says. "To realize our strategy, we need to have one organizational structure and one business support system in Europe. We can't stop the work on this process simply because market conditions, at the moment, are difficult. It's the same thing with the development of new products - costs come first, then profits. We will continue to restructure the European organization with the knowledge that costs will eventually decline, and profits rise... (Myklebust 1998).

3.3. Change agent

The original re-engineering project was intended to bring about radical change fast. In reality, the organization remained the same. The SAP project, on the other hand, was initially assumed to support the new re-engineered organization. Although the SAP project has been ambitious and permanently close to collapse, it has worked as a vehicle for organizational change. The organization is indeed changing – much slower than what top management believed when the re-engineering started, but much faster than before the SAP project was launched.

The change model in the SAP project was a two-stage rocket. First, establishing common work processes supported by a common SAP solution throughout the division. In the second stage the common processes should subsequently serve as a platform for further integration. The common work processes are assumed to make co-ordination between the different units easy, while some processes might be extracted out of the individual units and located to only one site, taking care of the process for the whole division. (Two such processes will be mentioned below.)

The original re-engineering project did not address technology. Not doing that, the existing technology could be a barrier for change as existing work routines and organizational structures were inscribed into it. At the same time, some medium for translating the abstract model for the integrated European organization held at the top level into specific changes at each single office and work task is mandatory. Information technology may well serve as that medium. And that is the operational strategy (although not the espoused one) behind the SAP project.

A technology like SAP is more than a pure software package to be tailored to specific needs. It also embeds established ways of using it as well as organizing the implementation project. This "formative context" (Ciborra and Lanzara 1994) is inscribed into the larger actor network SAP software is a part of. This network comprises SAP documentation, existing SAP implementation, experience, competence and practices established in the SAP "development community". The SAP implementation has been a guiding tool for selecting activities to address, and in which sequence they should be addressed. It has also been a tool and a medium for

representing, "designing", and implementing new work processes. As the process unfolded, SAP made issues appear: Should these processes be common across all Europe? If so, should a shared European function be established taking care of them? Several tasks have been found which could be centralized into one European unit. As the SAP implementation has a complexity almost beyond what can be managed even when the organizational changes are at the minimum, most issues are postponed until the SAP implementation is considered finished. However, for a couple of the issues identified, new integrated services are being implemented. The two major ones are the Single Distribution Centre (SDC) and the Operational Shared Services (OSS) unit.

SDC is a new unit through which all transactions between marketing and production units are channelled. It was established as a legal company, located in Paris, although it was without any staffing. This operation was established partly because a better structured way of dealing with internal transactions was needed, but most of all because this unit "logically" was required by SAP to avoid a tremendous amount of transactions which would slow down the system and confuse those involved or responsible. SAP is weak on supporting distribution and logistics. SDC compensates for that weakness. In this way that change is very much designed by SAP. SDC has been in operation since November'97.

OSS is a shared unit taking care of some finance and accounting services. The unit is geographically split between Porsgrunn in Norway and Sluiskil in Netherlands, the two major production sites.

We will look a bit closer at three roles SAP has played as change agent in HAE, namely as designer of the Bridge infrastructure, its role in diffusing Lotus Notes, and in the integration of HAE.

3.4. Bridge designer

The SAP solution runs on top of the Hydro Bridge infrastructure, as the SAP applications require – of course – PC's, operating systems, communication networks, etc.

The implementation of Bridge in HAE turned out to be strongly influenced by SAP. Shortly after the decision to go for SAP, those responsible for IT concluded that Hydro itself did not have the resources and competence to take responsibility for the required data processing and operations services. HAE then decided to outsource these functions to a major global facilities management company.

The SAP transaction processing would run on computers physically located in a large processing centre in UK. When the decision about outsourcing SAP processing was taken, it was also assumed that it would be an advantage if the same service provider also delivered the required network services connecting the client software on local PC's to the servers. So it was decided to outsource that as well. Having made this decision, they also came to believe that it would be beneficial to have just one provider responsible for the whole chain from the servers running the SAP database through the network to the hard-

ware equipment and software applications used locally. A contract was signed covering three areas, called processing, network and (local) site management. This contract meant that the design and operation of the Bridge network was handed over to the service provider, as was the responsibility for installation and support of all elements of Bridge locally (PC's operating system, desktop applications, the Notes infrastructure and applications, Internet software and access, etc.).

So far the outsourcing has been a mixed blessing. The network and processing services are fine, but site management (i.e. local support) is problematic. The major problems seem to be related to the fact that the actual global service provider has organized its business in independent national subsidiaries, and is not able to carry out the required co-ordination across national borders. In addition, some problems are related to the fact that the site management contract specifies that users should call the help desk in UK when they need support. The threshold for doing this is quite high for large user groups not speaking English, although the help desk should have people speaking all major European languages. When getting in contact with the help desk, problem solving is experienced to be much more difficult than when getting assistance from local support personnel. In this way SAP has made the support of Bridge far more complex than desired.

3.5. Notes pusher

To make the SAP project succeed people from all sites had to be involved to provide the project with the required knowledge about how tasks were performed and businesses were conducted at different sites. For a project of this size and distributed nature, smooth communication is mandatory. Notes applications have been used as e-mail systems, project document archives, and discussion databases. As such, Notes has been a crucial infrastructure making possible the required co-operation between all those involved all over Europe.

Notes was first adopted by the central project team, all located at the division headquarters in Brussels. Some of the local projects started to use these applications. After a while some of them set up their own Notes data bases for their specific project. Others, like the Italian project, did not use the central system but developed their own when one of the members of the central project moved to Italy.

Notes has been widely used by virtually all SAP projects in Hydro, and SAP projects have been the first users of Notes in many divisions. In that way SAP has been an important agent for making Notes widespread. The initiatives for using Notes have been taken by IT personnel familiar with the technology and optimistic about its potential contributions to Hydro's overall productivity and efficiency. As all SAP projects are large and involve numbers of different user groups, knowledge about and practical experience with the technology becomes widely spread. SAP projects seem to be the most intensive users of Notes, and accordingly SAP one of the most important actors in making Notes diffuse in Hydro.

3.6. Integrator

When the re-engineering project started, the different units inside the division were all unknown to each other. Tight integration means close collaboration. Close and efficient collaboration requires that those involved are parts of the same community, knowing each other well and having a shared background, culture and identity. Establishing such a shared "platform" takes time and can only happen through collaboration.

The SAP project has been the most important shared activity involving people from most parts of the division. Through the project people all around Europe have become acquainted with each other, learning about each other's ways of working and doing business – "best practices" are identified and tried transferred to other locations. Through this process the different units get ideas about how to improve their own work far beyond what is addressed by the SAP project, and they discover new areas where co-operation and integration would be beneficial. Collaboration on other issues has been initiated – and also supported by Notes applications.

4. SAP AS COMMUNITY MEMBER

Having illustrated how SAP is playing different roles as an actor, it remains to be understood how its agency is played out together with other actors, as one unit in a larger network – as a member of a larger community. In this community, each member acts individually. The effects are not caused by SAP only. They are the result of actions involving others – a network of aligned actors, or a number of actors having joined forces in alliances. As in political theory, actor network theory considers power as being related to the ability to align other actors to your own interests, i.e. making them your allies. For any actor, non-human (i.e. technological) allies are equally important as humans (Latour 1988, Introna 1997).

4.1. Other actors

Actors in the "SAP community" are designers, users, and managers. In the early phase of the re-engineering project, the managers were key actors. IT managers were important in making the SAP decision. As the SAP project evolved, lots of actors entered the stage. First project managers, then consultants were hired as designers and programmers. Later on users and local managers were involved in the four regional projects taking care of specifying local requirements, then the local implementation of the SAP system. These regional projects involved a significant number of people, as mentioned above, for instance, more than 100 in the Scandinavian one.

When the SAP system got installed, even more actors appeared on the arena. An important one has been the provider to whom the computing services were outsourced. Central servers, local PC's and the networks entered the scene as SAP's underlying platform. And as the users started adopting SAP into their working practices, these practices also started to play an active role in the project. These practices included other tools and systems. To

make SAP work smoothly, all these had to be aligned somehow. These systems included other applications for production control, planning and forecasting, more specialized financial analysis and reporting tools as well as the more general ones included in the Lotus SmartSuite package as part of the Bridge standard. As SAP approached its use environment, it became increasingly embedded into the socio-technical web constituting Hydro Agri Europe.

4.2. Alliances

During the evolving SAP implementation, alliances were built and changed as new actors were enrolled. When the project started, management was the sole actor, and of course the key one. SAP was chosen to help integrate the organization. In the early phase of the project, SAP was a close and important ally of top management to get the change process moving. And SAP was a powerful actor to make this happen. However, as more actors got involved, the network(s) changed character and new alliances were established.

Two alliances are worth mentioning here. The first one is an alliance between the user groups and SAP. The user groups were to specify local requirements. These included identifying the needs for each office. Some specific needs were due to established local practices – which, in principle at least, could be changed into common ones. Other needs, however, were outside Hydro's control. These include differences in national legislation concerning accounting, taxes, environmental issues, different transport systems in different nations/regions (railway, ships, trucks, river boats, etc.), etc. In addition there were differences in business cultures and market structures in different nations and regions. These local aspects must be accounted for in the design. And in this process locals played a key role. They took control over the design process, and also turned SAP into an ally helping them get control over the overall change process. The early alliance between SAP and division management was broken. This made the change process slower just as the locals initially wanted. Through this process the SAP solution was customized for each individual site, it changed from one shared, universal solution into one variant for each site. These variants had, however, much in common, and they were linked together. The SAP solution had changed from one coherent common system to a complex, heterogeneous infrastructure.

4.3. Agents shaping each other

SAP applications installed in different divisions were considered isolated and independent of each other. Recently SAP applications are linked together and hence emerging as corporate infrastructure. The Technology&Project division (HTP) is building most of Hydro's installations (mostly plants and oil platforms). When doing so, they are buying the equipment and materials needed. This has so far been done by means of the procurement systems of each division. To make these tasks easier, HTP is now developing their own SAP based procurement system. This system will be integrated with the procurement systems in all other divisions; many of these are SAP applications. Further, a corporate

Human Resource system is under development, and so is a shared module supporting plant maintenance.

To enable smooth integration of SAP and better utilization of resources, shared processing centres are needed, as well as a shared infrastructure of development and maintenance resources. The lack of such an infrastructure has been acknowledged as a major problem because most SAP applications development work has been done by consultants. They are hired for a project and leave when it is finished.

SAP applications are also integrated with other systems in a way making them parts of the overall corporate information infrastructure. Some divisions, for instance, are developing Notes interfaces to all their applications – including SAP – for infrequent users. Data from SAP applications are extracted and made available through the Web based Intranet, data are exchanged between SAP applications and applications such as spreadsheet (1-2-3) and other Bridge applications. Some SAP applications are also integrated with extensions tailored for specific sectors. One such is an accounting module, called IS-OIL, supporting joint venture production of oil fields. When different SAP installations are linked together with each other and with SAP extensions like IS-OIL, the process of moving from one version of SAP to the next – a problem which in principle is very simple – becomes very hard. Those responsible for the different parts will continuously wait for each other in order to align versions. Moving from one version to another is in addition very expensive and comprehensive. These problems are also acknowledged in the SAP literature (Bancroft et al. 1998).

As this complex SAP infrastructure is emerging SAP becomes increasingly harder to control – it becomes a more powerful and independent actor. Which role this actor will play is hard to predict. One role is, however, becoming visible. It is becoming hard to change. It may turn into a powerful actor resisting all organisational change. But to integrate HAE into one unit as envisioned requires radical change beyond what is supported by the current SAP solution. The future challenges are already perceived: "We have done things difficult for ourselves. We have customized too much". The customization, however, seems to have been the price to pay to enrol local users and managers into the project, and to counter the objections that SAP was a significant step back in functionality compared to existing local systems.

The difficulties in changing SAP installations are experienced by all divisions having reached this stage. At Hydro Agri North America, after two years of use, the users finally understand the technology and are becoming able to see how it might be used to improve their work. However, when proposing changes the response is that the SAP application is so complex that it costs all too much to change it. Experiences are similar in the oil division: "SAP is like concrete – it's very flexible until it sets. Then there is nothing you can do to change it".

These experiences are all related to isolated SAP installations. As more SAP installations are put in place and integrated into a corporate infrastructure, the individual

modules become important actors influencing the future development of the others in unpredictable ways.

5. CONCLUSION

An SAP installation in a global organization easily becomes a large infrastructure. It is an infrastructure designed and controlled by managers and IT personnel, but also an actor shaping its environment as well as its own future. Like any actor, the technology builds alliances with others. However, the alliances might change over time. In the case reported here, SAP first got allied with top management, playing the role as a powerful change agent. Later on SAP got allied with local managers and users, helping them bring the change process under their influence and into the speed they preferred. Currently, SAP is again changing its role as it gets installed and integrated into a larger corporate infrastructure. In a few words: it may become everybody's enemy by resisting all organizational change.

The changing roles of the SAP installations are basically due to its emergent infrastructural character. The SAP installations have been seen as ordinary information systems, and to be designed as such. In the beginning of the project, the SAP implementation had the form of a systems design activity. However, this form vanished. The change from system to an emergent infrastructure can be outlined as a four-step transformation. First, the set of SAP applications got a flavour of infrastructure due to its big size, the number of units and functions to be supported, and the number of users, managers, and developers involved. The second step was the crumbling of the SAP application as one common universal and system for all units. During the validation and the following implementation process, major customization of the application to different local needs took place. During this customization, the application changed from one universal and common application towards one for every single organizational unit – a large number of overlapping and interconnected applications, i.e. a complex heterogeneous infrastructure. The third step was the integration of SAP and the Bridge infrastructure, and through this even with the Internet. Finally, the SAP installation in HAE is becoming integrated with others. At that point, the installation in HAE will be a part of and deeply embedded into large and complex infrastructures. How the SAP installation in HAE may be changed will very much be determined by this infrastructure, and not designers or HAE managers.

Viewing an SAP installation as an ordinary isolated information system seems common among virtually all in Hydro. In fact, the organization seems still to be blind for SAP's infrastructural character. However, some learning is taking place. The complexity of SAP implementations is acknowledged, and so is the importance of learning from each other's project and to build up shared development and maintenance competence. The establishment of networks and institutions to support increased cross-divisional learning is taking place. On the other hand, the challenges one will be confronted with in the future due to the difficulties in changing SAP

infrastructures seem not to worry anybody.

So what? Going deeply into discussions about what kind of design strategies should be derived from an actor-network perspective seeing technology as an actor in general, or even to deal with powerful irreversible infrastructures is beyond the scope of this article. However, one can make a few comments on how to deal with infrastructures and their irreversible installed base. A twofold, or dual, strategy could be possible: on the one hand it is important to fight against the power of the installed base by building an infrastructure in a way that makes it possible to avoid being trapped by it. This means making it as flexible as possible. Flexibility can be obtained through general strategies like modularization and simplicity. In the context of infrastructures this means that one should develop independent systems for smaller units and define simple interfaces between them, rather than one common universal system which includes all functions needed by anybody. When modularizing infrastructures to make them flexible, gateways are key tools (David and Bunn 1988, Hanseth and Monteiro 1998).

The other part of the proposal is somewhat the opposite: make the installed base your ally by designing the new infrastructure in a way that builds upon the installed base as it is, rather than establishing a new one. The development and diffusion of the Web demonstrates the success of this strategy in the way the Web protocol (HTTP) and its data format (HTML) are designed to build upon the Internet's basic protocol (TCP/IP) and its format for multimedia information (MIME).

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