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The Control Devolution
ERP and the Side-effects of Globalization

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Abstract

When looking at the implementation of ERP systems in large organizations, the typical business concerns span from attaining the goals of the application, usually globalization and efficiency, securing the organization's acceptance, avoiding rigidity and so on. By now, the literature is full of both normative models on how to implement ERPs successfully and cautioning tales of how the road to success is paved by traps, slowdowns and even disillusion. This paper does not want to take sides in this emerging literature, simply because it submits that there is a need to look at the broader context of ERPs implementation. There is a need to discover new meanings before turning to consulting or critique. Such meanings stem from re-considering the managerial concepts that accompany the ERP implementation, especially the issues of "what is an ERP"; how to do strategic alignment; and what does globalization really entail. The authors frame the study of ERP in organizations within the broader context of an analysis of the consequences of modernity. The new vocabulary sheds a different light on what organizations are doing with ERP: these systems are open, pasted-up, uncontrollable expanding infrastructures; strategic alignment flounders in never-ending tactics and compromises; globalization

generates side-effects. Harnessed to enhance control over complex, global organizations, ERPs enshrine the consequences of modernity in a nutshell: they accelerate organizational drift and runaway. The case of the introduction of SAP in a large Norwegian company illustrates a range of drifting processes and side-effects.

1. Introduction

The leit motiv of this paper is "managerial governance and control of the IT resource" – in particular to what extent development and implementation of ERP solutions can be governed and to what extent control over the user organization is an objective behind the ERP deployment. We argue that governance is indeed a central issue in relation to ERP implementations, but a highly challenging one. ERP systems with their emphasis on standardization, streamlining and integrating business processes are an ideal control technology. Still, our research puts forward a surprising idea: implementing an ERP system in order to enhance control over a global organization may just as well deliver the opposite result, i.e. less control. Such an idea comes as a surprise only if one relies on the normative contents of prevailing management perspectives on information systems (IS). It is an outcome to be expected, however, if one looks at the deployment of information technology from alternative perspectives. One such is the theory of globalization and reflexive modernity.

Control and governance are core issues underlying virtually any strategy or approach for developing and using IT solutions. In general, this perspective is most explicitly spelled out in James R. Beniger's (1986) analysis of the control revolution. In his book he describes all technologies as tools to help their adopters to improve their control over processes in nature and society (like for instance production and distribution processes). IT is regarded as the control technology *par excellence*, and the so-called IT or information revolutions are control revolutions, i.e. revolutions in terms of our control capabilities.

The main objective behind the development and implementation of a new IS system, like an ERP, is to enhance control over processes within the user organization. The objective can be obtained in different ways. First, the user organization gains higher control over its IS application portfolio because a large number, in some case more than one hundred, separate systems and applications are replaced by an integrated one. Second, better governance is achieved through integration of the data created and used in different parts of the organization. An integrated system enhances the mangement governance capabilities. Thirdly, more effective and comprehensive control is obtained when the ERP system is implemented in parallel with a BPR project integrating the different units: this can make it easier for management to streamline and centralize the whole organization.

The strategic context where such moves, innovations and implementations take place today for large companies is the one of *globalization*. We will discuss how these two themes – globalization and ERP implementation – relate and interfere with each other in general and with regards to control in particular. This will be done by applying Anthony Giddens' (1991) and Ulrich Beck's (1992) analyses of globalization and modernization, or reflexive modernity, to the special case of the implementation of

SAP in a global Norwegian corporation, Norsk Hydro. The study shows first that the ERP system is implemented according to traditional managerial models focusing on efficiency, rationalization and hierarchical control. The same applies for the identification and development of Norsk Hydro's globalization strategy.

The analysis will show, however, that using, maintaining and implementing such technologies in global organizations are better characterized by Giddens' (1999) general description of living in the modern world like being aboard a careering juggernaut. He uses the juggernaut as an image to illustrate modernity as a "runaway engine" of enormous power. It is a runaway device in the sense that we collectively can steer to some extent, but that also threatens to rush out of our control. The juggernaut crushes those who resist it, and, while it sometimes seems to have a steady path, there are times when it veers away erratically in directions we cannot foresee. The juggernaut of modernity is far from being monolithic and coherent. It is not an engine made up as an integrated machinery, but one in which there is a push-and-pull of tensions, contradictions, and different influences. ERPs in use are composite infrastructures, which seem to behave in such an erratic way. As we shall see this is caused by the relentless emergence of side-effects stemming from the intertwined dynamics of technology and globalization.

The paper starts by reviewing the managerial perspectives on globalization strategies and the related governance of IT solutions (Section 2), in order to show how such an agenda is narrow when compared with the perspective of the theory of modernity, globalization and reflexivity. (Section 3). The next two Sections present the case of the SAP implementation in Norsk Hydro, indicating how the management perspective really dictates the deployment agenda in every detail (Section 4); but also how a number of positive and negative unexpected consequences of SAP can only be explained adopting the theory of modernity (Section 5). Concluding remarks on the usefulness and complementary role of the latter perspective follow.

2. The Management Perspective: Globalization Strategies and IT Solutions

In the management literature globalization is widely acknowledged to be an important contemporary phenomenon. Globalization and technology are mutually reinforcing drivers of change (Konsynski and Karimi, 1993). The role of IT as a key factor to bring about this change is often thought of as an opportunity to enhance control and coordination, while opening access to new global markets and businesses (Ives and Jarvenpaa, 1991). Barlett and Ghoshal (1998) suggest that firms operating in global markets are at a serious strategic disadvantage if they are unable to control their world-wide operations and manage them in a globally coordinated manner. According to their model corporations should focus on closer coordination of increasingly more complex and global processes.

Bartlett and Ghoshal (1998) identify four strategies among which a multinational corporation may choose. In the process of becoming increasingly global, firms are supposed to follow a sequential path through these strategies: from multinational to international, to global, and finally to transnational. For example, a company pursuing

a *multinational strategy* operates its foreign subsidiaries nearly autonomously, or in a loose federation so as to quickly sense and respond to diverse local needs and national opportunities. In the model the value chains are duplicated across countries, and the local units have a strong degree of autonomy. The company pursuing an *international strategy* exploits the parent company's knowledge through world-wide diffusion and adaptation. Rapid deployment of innovation is the prime operating principle.

Instead, a firm pursuing a *global strategy* closely coordinates world-wide activities through central control from headquarters gaining benefit from a standard product design, global scale manufacturing, and centralized control of world-wide operations. According to this strategy, the firm is based on a centralization of assets, resources, and responsibilities. The decisions are still decentralized but controlled by the headquarters and organized to achieve global efficiencies.

These models and strategies focus on integration and control. Each strategy tries to go one step further along these dimensions than the previous one.

Barlett and Ghoshal are arguing that companies now should move beyond the global model and converge towards a common configuration because of the complex environment, technological change, and creation of large integrated markets. The new organizational solution is called the *transnational model*. This model tries to combine the needs for integration and control, on the one hand, and flexibility and sensitivity towards local needs, on the other.

The information-systems literature addresses the link between IT and globalization. In their study on managing IT in global companies, Ives and Jarvenpaa (1991) found four generic patterns, which they see as aligned with the strategies proposed by Bartlett and Ghoshal.

One pattern is the independent global IT operation, where the subsidiaries pursue independent systems initiative and common systems are the exception. Technology choices reflect the influence of local vendors and prevailing national communication standards, resulting in a lack of integration in both hardware and software. This pattern most closely relates to the multinational strategy, with the focus on local responsiveness and the application portfolio strongly oriented toward local requirements.

Another pattern is the headquarters-driven global IT, where the firm imposes corporate-wide IT solutions on subsidiaries. The compelling business need and the opportunity to harvest world-wide economies of scale force the firm towards a global systems solution. This approach is aligned with the global strategy. Ives and Jarvenpaa found that, without a strong global business need, the headquarters-driven global IT approach runs into problems.

3. The Modernity Perspective: Globalization and Reflexivity

Before turning to the case study, and to prepare ourselves to the surprising outcomes of the ERP implementation in that context, we need now to look into the nature of globalization processes from another standpoint. We will do this on the basis of

Giddens' (1990) and Beck's (1992) theories of globalization and reflexive modernity. They point to aspects largely absent from the management perspectives and models, but we believe they are very relevant to understanding the dynamics of IT in global companies.

3.1 The essential dynamics of modernity

To analyse globalization, Giddens (1990) argues, we have to look at the nature of modernity itself'. He sees three dominant, interdependent sources of the dynamism of modernity:

The separation of time and space, which has in particular been possible through the invention of various technologies such as the clock, the standardization of time zones, calendars, and so on. These tools are essential to the coordination of activities across time and space. (See e.g. (Yates, 1988) on the importance of standardization of time (zones) and the invention of timetables for the development of railroad traffic.) Powerful tools for coordination across time and space are preconditions for the rationalization of organizations and society and the development of more powerful control technologies (Beniger, 1986).

The development of disembedding mechanisms. These mechanisms enable the 'lifting-out' of social activity from localized contexts and the reorganization of social relations across large time–space distances.

There are two main disembedding mechanisms: symbolic tokens and expert systems. Giddens does not define symbolic tokens but presents a paradigm example. Other examples are 'other forms of money'—stocks, bonds, funds, derivatives, futures, and so on. 'Symbolic tokens' can also be interpreted as various forms of *formalized information*. 'Expert systems' mean systems of experts and expert knowledge. Expert knowledge—under modernity—is developed under regimes underlining universality and objectivity. Expert—and scientific—knowledge should be built up of facts, theories, and laws that are universal and not linked to specific contexts or subjective judgements. The fact that expert knowledge is free of context implies, of course, that it can be transported anywhere and applied to anything. Both forms of disembedding mechanisms presume as well as foster time–space distantiation.

The reflexive appropriation of knowledge. Modernity is constituted in and through reflexively applied knowledge. This means that social practices are constantly examined and re-examined in the light of incoming information about those very practices, thus constitutively altering their character. The production of systematic knowledge about social life becomes integral to systems reproduction, rolling social life away from the fixities of tradition.

3.2 Modernization as integration and control

Globalization and modernization is closely related to integration and control. Both Giddens and Beck see increased control as the key motivation behind modernization efforts and, further, integration as a key strategy to obtain higher control. Time-space distantiation is largely about enabling the integration of process across time and

space. The same is the case for the development of disembedding mechanisms. Symbolic tokens and expert systems can be established as common for communities otherwise distinct and separated. By sharing disembedding mechanisms communities are becoming more equal, they have more in common which makes interaction and collaboration easier, i.e. they are becoming more integrated.

Modernization and globalization are closely connected. Actually, globalization is the most visible form modernization is taking. It means modernization on the global level. And, as a part of this, modernity itself is inherently globalizing.

The modernization and globalization processes Beck and Giddens describe are exactly what happen when moving from one of the organizational models presented above to the next (i.e. from multinational to international to global).

3.3. Consequences of Globalization and Modernization: Risk Society

What are the consequences of modernity that may affect businesses?

A first general consequence of modernization and globalization is the emergence of what Beck (1992) calls 'risk society'. He uses this term to argue that most characteristic of our contemporary society is the unpredictability of events and the increased number of *risks* with which we are confronted. Consider, for example:

- the globalization of risk in the sense of its intensity—for example, the threat of nuclear war;
- globalization of risk in the sense of the expanding number of contingent events that affect everyone or at least large numbers of people on the planet—for example, changes in the global division of labour;
- risk stemming from the created environment, or socialized nature: the infusion of human knowledge into the material environment;
- the development of institutionalized risk environments affecting the life chances of millions—for example, investment markets.

Obviously, all these risks affect global corporations. In particular, we submit that the second one - the risks created in terms of a growing number of contingent events affecting more or less everybody – is most relevant for interpreting the case study that follows. Contingent events include those taking place in one local context inside a corporation, which affect 'everybody' inside it. The more a global company is integrated into one unit, the more this kind of risk arises. But modern corporations also get more integrated with their environment—customers, suppliers, partners in strategic alliances, stock markets, and so on. Such companies get more affected by events taking place in other companies or other parts of their relevant environment.

Increasing risk means decreasing control. In this respect, current modernization and globalization processes represent a break from earlier modernization. Traditionally, modernization implied more sophisticated control according to the tenets of the 'control revolution' (Beniger, 1986). More knowledge and better technology implied sharper and wider control. In the age of high modernity and globalization, however, more knowledge and improved control technologies may just as well lead to *more*

unpredictability, more uncertainty, and *less controllability,* in one word - *more risk.*

This is what lies at the heart of the "reflexivity" argument. In particular, the theory of reflexive modernization contradicts the instrumental optimism regarding the predetermined controllability of uncontrollable things: 'the thesis that more knowledge about social life . . . equals greater control over our fate is false' (Giddens, 1990: 43), and 'the expansion and heightening of the intention of control ultimately ends up producing the opposite' (Beck, Giddens, and Lash, 1994: 9).

This shift, which may appear contradictory, can be explained by *the ubiquitous role of side effects.* Modernization means integration. At the same time, all changes and actions - new technologies introduced, organizational structures and work procedures implemented, and so on - have unintended side effects. And, the more integrated the world becomes, the longer and faster side effects travel, and the heavier their consequences. Globalization, then, means globalization of side effects. In Beck's (Beck, Giddens, and Lash, 1994: 175, 181) own words: 'It is not knowledge but rather non-knowledge that is the medium of reflexive modernization . . . we are living in the age of side effects . . . The side effect, not instrumental rationality, is becoming the motor of social change.'

4. Implementing SAP in a global organization

We now turn to the empirical evidence: the implementation of SAP R/3 in Norsk Hydro, specifically in its European fertilizer division called Hydro Agri Europe (HAE). Globalization is an important element in the company's change strategies and its approach to globalization does not only follow the leading management models, but can be looked at as a classical example of modernization as outlined by Beck's and Giddens' work above. The SAP implementations also fit into this scheme – they are carried out as a part of the modernization process. Technology does not only support this form of change; it reinforces it as well.

But implementing the ERP systems is a double-edged process, in which modernization and globalization through integration may strike back. All integration tasks have side-effects, and these side-effects add up. The integration efforts have a reflexive character that change the role ERP systems play in the organization, in ways that may be just as important as the intended effects. At the utmost, SAP is producing opposite effects to those one would expect from this technology.

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

To be fair, however, the study method could not be fully in line with Klein and Myers' views, since we learnt along the way what theory would be of more effective help in interpreting the data. Thus, we collected the data with some theories in mind

(e.g., Actor-Network Theory (Latour, 1987) or the economics of networks) and only later on “discovered” the relevance of discussing and interpreting our empirical data using Giddens’ and Beck’s theories. We think that this way of proceeding is legitimate to the extent to which the various theories we have been using in the research project are not in contradiction, rather they can be selectively applied to the case analysis (micro level) and to the interpretation of more general impacts. We let the reader appreciate in what follows only the general interpretations obtained by using the theory of modernity. The microanalysis carried out using Actor-Network Theory and Network Economics is reported in Ciborra et al. (2000).

4.1. Globalization and IT infrastructure strategies in Norsk Hydro

Norsk Hydro is a diversified Norwegian company, founded in 1905. From 1972 to 1998 its turnover has grown from 1 to 96 billion NOK. Besides its original fertilizer business, it produces light metals, oil and gas. Currently it is present in more then seventy countries around the world. 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 organizational integration and synergy among the different units have been increasingly emphasized. This includes the establishment of “common processes” across all divisions. In the same period 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 have been set up to achieve these goals. For example, consensus was reached in the early 90s about the need for a common protocol (TCP/IP), and a corporate standard, called Hydro Bridge, for desktop and communications applications. At the time of the study, there was about 20,000 Bridge users. Over the years, however, with the proliferation of systems and applications (Windows, new operating systems, networks etc.), Bridge became an umbrella standard. It includes Hydro’s global network as well as a wide range of applications. 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 extended. Lotus Notes and the rest of Bridge are seen as important tools supporting this trend. Notes diffusion, for example, has been aided by the development of an infrastructure of more than one hundred servers. After a slow start, Notes use has gained momentum: about 1500 applications are in operation at the beginning of 2000.

Starting in the mid 90s Hydro has been building a considerable corporate SAP based infrastructure. The first SAP applications were installed in France in 1990. SAP was selected as corporate ERP standard in 1994.

Hydro Agri Europe is the largest division and the home of the most ambitious SAP project. It includes 19 production sites, and in total 72 sites throughout Europe. (Since the 80’s Hydro has bought several fertilizer companies all over continent).
In line with traditional Hydro management policy, the acquired companies were run “hands off” (i.e. as autonomous as possible). In 1992 the market prices tumbled, bringing the whole division into a crisis. In this situation the division management decided that operations in Europe should be integrated into one unit.

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

The change plans raised very strong resistance. Resistance could be observed at all levels in the organization, not least by top management of the different national companies. Soon after the integration decision was made, a group working on central production planning was established. The rest of the change was implemented through "change agents working from the middle." That meant people were working full time on the change without, however, being in the position to make any major decisions. As a result, they were frequently "shown the door" when visiting local offices and plants. Thus, no significant change took place.

Globalization has definitely impacted Norsk Hydro. Their traditional organizational model has been the one Barlett and Ghoshal (1998) call *multinational*. This model was also prevailing in the European fertilizer division when the re-engineering project was started. The objective of the project was to implement a model very close to the one Barlett and Ghoshal describe as the *global* corporation.

The IT strategies appear to be well aligned with the business strategies and they are following the pattern described by Ives and Jarvenpaa (1991). Specifically, when the fertilizer division was following a multinational organizational model, their IT activities were in line with what Ives and Jarvenpaa call an independent global IT operation. And as they decided to change their organizational model into a global one, they planed to implement what the same authors call headquarter-driven global IT operation.

From a different perspective, Norsk Hydro's globalization strategy in general, and the change plans for the European fertilizer division in particular, are in perfect line with Beck's and Giddens' analysis of modernization as presented above. The primary motivation is to become more global by expanding their operations and at the same time sharpen their control over these increasingly global operations. The key strategies to achieve this consist of organizational integration and improved, i.e. more integrated IS systems and infrastructures. Increased integration of the organization can be achieved by leveraging the time - space distantiation, i.e. technologies improving the capabilities for collaboration and integration across time and space.

4.2 Re-engineering and SAP implementation

The re-engineering project the European fertilizer division embarked on raised serious challenges for those in charge of the project (i.e. the top management of the division). In order to avoid losing control of the process, and wanting to achieve the planned outcome, they needed more powerful control technologies. SAP R/3 turned out – by accident - to be such a control technology – at least for a period.

When the re-engineering started, IT management soon reached the conclusion that the division could not be integrated on the basis of an 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, communication networks were delivered from different vendors. Virtually any available technology was in use somewhere. To deal with this problem HAE launched in January '94 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 R/3. Thus, 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 implementation project started in early 1995, and was planned to be finished by mid ´99.

The project activities were split into three phases:

1. Development of a pilot and its implementation in one factory and sales office in Germany.
2. Validation of the pilot. This comprised
   - validating the pilot in terms of a gap analysis specifying required changes and extensions for other units;
   - developing the "final" version.
3. Implementing the final version in the whole division.

When the pilot was installed, it took three months of extensive support to make it work properly. When the validation started, five regional project teams were set up. Typically, the project covering the Scandinavian plants and offices had more than 100 members. The validation effort 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 managers also argued that the "final" version should be based on a complete redesign of the pilot, as the latter was not structured as well as the more complex "final" version would require. This did not happen.

During 1998, the teams were also struggling to keep the project moving against obstacles, such as its complexity, the young age of the organization, and the huge cultural differences. According to key members, major difficulties were due to lack of understanding of what this was all about – i.e. it was not "just another IT project." On the other hand, people felt exhausted and wanted to finish the SAP project as soon as possible, so there was little resistance left.

When the SAP initiative started, the original re-engineering project was subsumed into it. The specific objectives of the re-engineering project were, however, still alive - now expressed as "one single integrated European learning organization."

The focus of the re-engineering work was on establishing "common processes" across the whole organization. When these were in place they were assumed to serve as a platform for closer integration. The changes are most significant in the "front" (i.e. sales) offices. The sale offices would be selling all products manufactured by the division, not only those provided by the local plant.

The re-engineering project showed from the very beginning that restoring control in

order to move towards more globalized forms of running the business was a challenge, due to the complexity of the organization itself and the process of radically changing it. The European fertilizer division could be seen as being only partly under the control of the top division management. But the establishment of the SAP initiative changed all this. A consequence of this initiative was also that some serious change activities started and some real change in the organization was taking place. The model for how to organize the project proved to be a technology which enhanced management's control over the change process significantly (more on this in section 5.2.1.).

4.3 Globalizatoion as Modernization in Norsk Hydro

The objectives and strategies behind the re-engineering and the SAP implementation are all typical examples of Giddens' outline of globalization as modernization. The change model intended to be followed by the SAP project was a two-stage rocket. First, establishing "common work processes" supported by a common SAP solution throughout the division. These common processes should be established by identifying "best practices" which then will be copied by the whole organization. In the second stage, the common processes would subsequently serve as a platform for further integration into one profit centre. The common work processes were 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.

The concept of "best practices" is exactly what Giddens (1990) calls dis-embedding mechanisms. This change strategy implies that first "best practices" within a field are identified, then they are dis-embedded by being described in context free terms, and finally they are re-embedded into other local contexts. The implementation of common processes may enable enhanced integration and control in two ways. It becomes easier, for instance, to monitor and control sales processes in all offices from the headquarter if they are all equal. It also becomes easier to integrate, for instance, all sales offices and all plants if the production, distribution, and sales processes are all equal.

If "common processes" are implemented as an iterative process to improve existing practices over time, which is expressed by the slogan "one single European learning organization," this strategy is also a good example of "reflexive appropriation of knowledge".

The SAP implementation project was intended to support the organizational integration. And the very idea behind SAP, and ERPs in general, is indeed to provide their user organizations with more integrated information systems portfolios and in that way enabling tighter organizational control. SAP supports organizational integration basically in two ways. It is a technology enabling increased collaboration and communication across time and space (i.e. it is a technology contributing to the separation of time and space) through a shared data base. Further, SAP contains a large number of defined "processes," i.e. working procedures the user organizations have to adopt to use the system. In that way SAP is also a dis-embedding mechanism

in itself. SAP works as a dis-embedding mechanism because it contains a "language," i.e. symbolic tokens, in which processes may be specified and represented.

5. Globalization and its consequences: SAP as Risk Society

We will now look deeper into some aspects of the SAP implementation as a part of the globalization process in the European fertilizer division. Throughout the evolving implementation, the project organization was linked to and integrated with various organizational units, and the SAP applications were integrated with other systems and infrastructures. These linkages affected the project organization as well as the design of the installation itself.

We will first describe the various networks the SAP project was integrated into and then the side-effects and reflexivity this caused. The SAP implementation and the networks it increasingly became a part of turned out to be a "runaway engine," i.e. increasingly outside the control of the division management (and the management of the SAP implementation) and living a life of their own. Through side-effects and their reflexivity SAP installation and the organization hosting it are becoming a sort of risk societies themselves and also integrated into and contributing to the creation of a global risk society.

5.1 The ubiquity of integration

Integration efforts are often consciously planned and coordinated, like, for instance, the re-engineering and SAP implementation projects. Other integration efforts are carried out locally when some kind of disorder is discovered without thinking carefully through what kind of integration would be best for the organization, or whether integration is really the appropriate thing to strive for. It is usually taken for granted that pieces that interfere with each other should be carefully integrated. This causes blindness for potential negative effects of integration. In what follows, some examples are presented of how this kind of integration took place during the SAP implementation in HAE.

5.1.1 Local networks and fragmented integration

The SAP project was initiated by the central division management staff at the division headquarters in Brussels. Accordingly, close links between the division management and the project organization were set up. And through these links the division management shaped the project in important ways – at least in the beginning. However, as the project evolved, links with other groups and units were also established. These links influenced the project in different ways from what the management wanted.

A number of user groups were created. Their task was to specify local requirements. These included identifying the needs for each office. Some specific needs were due to consolidated local practices - which, in principle at least, could be changed into common ones. Other needs, however, were outside Hydro's control. These included differences in national legislation concerning accounting, taxes, environmental issues, multiple 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 those nations and regions.

These local aspects must be accounted for in the design. And in this process the locals played a key role. They took, in fact, control over the design process, and turned SAP into an ally helping them getting control over the overall change process. The early alliance between SAP and the top management of the division broke down. This hampered the change process, just as the locals had wanted initially. As a consequence, the SAP solution was customized for each individual site. Although it changed from one shared universal solution into one variant for each site, these variants had much in common and were linked together. Slowly, but irreversibly, the SAP solution had changed from one coherent common system to a complex, heterogeneous infrastructure.

5.1.2. Bridge infrastructure

SAP runs on top of the Hydro Bridge infrastructure, as the applications require - of course - PC's, operating systems, communication networks, etc. This means that SAP and Bridge are integrated. This kind of integration was considered so obvious that it was taken for granted, which again generated blindness about the consequences. Specifically, the integration caused – due to its side-effects - the implementation of Bridge in HAE to be strongly influenced by SAP. And these side-effects were in fact reflexive; implying that the way SAP shaped the Bridge implementation had consequences for the SAP implementation itself. These points will be illustrated below.

5.1.3. Towards a matrix infrastructure

The SAP installation in HAE, as well as those in other divisions, was considered isolated and independent. Later on, SAP applications were linked together and became more of a corporate infrastructure. For example, the Technology & Project division (HTP) which builds most of Hydro's installations (plants and oil platforms), buys equipment and materials by means of the procurement systems of each division. At the time our data collection ended, HTP was developing its own SAP based procurement system to make this job easier. The system is going to be integrated with the procurement systems of the other divisions (many of these are SAP applications). Further, a corporate Human Resource system is being developed, and so is a shared module supporting plant maintenance – both based on the SAP modules for these two functions.

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, since 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. In the Oil & Gas division, for instance, SAP has been integrated with 31 other applications.

SAP is a system designed to satisfy the needs of users in a wide range of types of

business organizations. Accordingly, the overall system as well as the user interface are rather complex – much more complex the systems being replaced, which usually are tailored to the specific needs of their users. For this reason many potential users simply refuse to adopt it. To overcome this problem some divisions are developing Notes and Web interfaces to their SAP installations. Further, data from SAP applications are extracted and made available through the Web-based Intranet, data are exchanged between SAP applications and spreadsheet packages and other Bridge applications, etc. Some SAP applications are also integrated with "SAP extensions" developed for specific sectors or user groups. For example an accounting module, called IS-OIL, developed by Andersen Consulting (now Accenture), which supports accounting in joint venture production of oil fields, is used in the Oil & Gas division.

Note the overall outcome of these concurrent initiatives. The various SAP applications and their links to other applications become a sort of "matrix infrastructure". 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 is very simple - becomes very hard to handle. Those responsible for the different parts will continuously have to wait for each other in order to align versions. Moving from one version to another is in addition very expensive and comprehensive. Such problems are also acknowledged in the SAP literature (Bancroft et al., 1998).

5.2. Side-effects

The emerging matrix infrastructure is the ideal ground for uncontrollable side-effects to show up as clusters of *domino effects*. We need to understand the process through which SAP was linked to and integrated with other networks, what side-effects this generated, and how side-effects propagated through these networks. Some side-effects were negative, others positive. The aggregation of side-effects give to the installed SAP the character of a "runaway engine."

5.2.1. SAP generates organizational integration

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 ambitious SAP project has been permanently close to collapse, it has worked – at least for a period - as a vehicle for organizational change. The organization is indeed changing – much slower than top management believed when the re-engineering started, but much faster than before the SAP project was launched. The change process as it has unfolded was more a side-effect of the SAP implementation, than the intended one where the new organization was developed first, and then the SAP installation was designed to enable it - or even one where the new organization and its IT support were launched together as advocated by most of the literature.

The original re-engineering project did not address technology. By not doing that, the existing technology could be a barrier to 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 was mandatory.

Information systems and their implementation projects may well be such a medium - and the SAP project was.

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 which are further embedded or inscribed into the documentation, existing installations, experience, competence and practices established in and shared by the SAP "development community," etc. 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 special issues come to the surface: Should these processes be common across Europe? If so, should a shared European function be established to take care of them? Several tasks have been found which could be centralized into one unit. As SAP 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 are channelled. It is a legal company, located in Paris, although without any staff. This unit 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 considered weak on supporting distribution and logistics. SDC compensates to some extent for that weakness. In this way that change is very much designed by SAP. SDC has been in operation since November'97. This example also illustrates how SAP works as a dis-embedding mechanism, i.e. how processes and work practices inscribed into SAP are re-embedded in new local contexts.

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.

5.2.2. Domino effects and the design of the Bridge infrastructure

The decision about outsourcing the SAP operations had significant side-effects. These side-effects propagated to new networks which again created further side-effects. Here we can talk about a domino-effect rather than just individual side-effects.

Shortly after the decision about implementing 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. They then decided to outsource these functions to a major global company delivering that kind of services.

The SAP transaction processing was going to run on computers physically located in a large processing centre in the UK. After the decision about outsourcing SAP processing was made, it was 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, those tasks were outsourced as well. Next, management came to the conclusion 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 hardware equipment and software applications used locally. Accordingly, a comprehensive contract was signed covering the three areas called processing, network and (local) site management. The contract meant that the design and operation of the Bridge network were 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 lacking. One major problem seemed to be that the global service provider has organized its business in independent national subsidiaries, but is not able to carry out the required co-ordination across national borders.

In the late nineties SAP set up a strategic partnership with Microsoft and integrated SAP R/3 tightly with the relevant Microsoft products, primarily the tools in the Office package. After this event SAP was not very keen on supporting any kind of integration with Lotus products. Over time, the perceived importance of tight and seamless integration between the SAP installation and the Bridge applications was growing significantly within Hydro Agri Europe as well as the rest of the corporation. And the tighter the Microsoft applications were integrated, the more serious the lack of integration with the corresponding Lotus applications was considered. For this reason Norsk Hydro decided to replace the Lotus applications (except Notes) with Microsoft Office. Doing so had a considerable cost. They had to buy licenses for all their approximately 40.000 employees and make Office fit into the Bridge standard and infrastructure. This includes specifying how it should be integrated with the other Bridge components, developing all require installation and configuration scripts, and install it on all PC's around the world.

5.2.3. Diffusion of Notes

Another side-effect of the SAP project – and this time a positive one – has been the diffusion of Lotus Notes. To make SAP 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 throughout Europe.

Notes was first adopted by the central SAP project team, located at the division headquarters in Brussels. Some time later a number of the local projects started to use the same applications. After a while some of them set up their own Notes applications

for their specific project. Others, like the Italian development team, did not use the central system but launched 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 often they have been the first users of Notes in many divisions. In that way the SAP systems have been important agents 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 have become widespread. 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.

5.3. Reflexivity and lack of control

Finally, we consider the role of reflexivity. Side-effects propagate through various networks, then they sometimes come back and affect the very phenomena which generated the initial side-effects. This happened in the case of the SAP implementation and the integration efforts themselves, which then contributes to the creation a risk society.

As in the case of side-effects, reflexivity may have positive as well as negative consequences. This means that side-effects can reinforce as well as destroy initial goals or actions. Reflexivity may then include self-reinforcing as well as self-destructive processes (Lanzara, 1998). The processes described here as examples of reflexivity having positive effects have much in common with those processes caused by self-reinforcing mechanisms and network externalities in network economics (Arthur, 1989; Shapiro and Varian, 1999).

5.3.1 Self-reinforcing processes: Integration generating more integration

When the re-engineering project started, the different units inside the division were all unknowns to each other. Tight integration means close collaboration. Close and efficient collaboration requires that those involved be 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.

SAP 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" have been identified and transferred to other locations. Through this process the different units could generate and share ideas about how to improve their own work far beyond what was addressed by the SAP project, and discover new areas where co-operation and integration would be beneficial. Collaboration on other issues has been initiated - and always supported by Notes applications. In these examples the value of collaboration rises as the number of people collaborating increases just in the same way the value of a standard for its users increases as more users adopt and use the standard (Grindley, 1995).

Some of the side-effects of SAP had consequences for the diffusion of Notes, at the same time as some of the side-effects of Notes impacted the SAP projects. These side-effects interacted in such a way to generate a self-reinforcing process. SAP made Notes popular because Notes was an important tool for the SAP project. Notes made the SAP project more manageable, efficient and successful than it would have been without such a tool. And the more the SAP project used Notes, the more those involved, and even the rest of the organization, learned about Notes and how this tool could be used also for supporting other tasks. When they learned more about the usefulness of Notes in other areas, this also enabled them to use Notes as a more efficient tool in the SAP project, and so on.

5.3.2. Self-destructive processes: Integration strikes back

Integration is, generally speaking, a strategy for making what is interdependent but poorly fitting fit. Thus, the integrated systems or processes can be efficient and at the same time simpler and cheaper to maintain. But this is not always true.

Indeed, this strategy is the main rationale for the ERP systems and their implementation in user organizations. It is believed that replacing several (in some cases more than one hundred) separate systems, which are integrated in ad-hoc ways, with only one, will give significant benefits in terms of more efficient business processes. At the same time, the overall systems maintenance costs will drop because maintaining one integrated system will be cheaper than maintaining all the individual ones plus all the ad-hoc links between them. The idea is seductive and makes economic sense.

But integration means increased interdependence. This creates problems in case of change. The closer a number of components are integrated, the more changes in one have implications for the others. Since we started developing software we have experienced that change and flexibility are of utmost importance. For exactly this reason modularization – i.e. keeping things apart, or "de-coupling" - has been a key to the development of high quality software. Accordingly, it should not come as a big surprise that ERP installations are generating significant maintenance challenges for their user organizations.

The outsourcing of the SAP processing was in itself successful. But the Bridge infrastructure was necessary for running the SAP installation. Accordingly, the bad quality of the services delivered that were related to the support of the Bridge infrastructure also affected the use and usefulness of SAP in a negative way. Because both SAP and Bridge on the one hand and SAP "processing" and "site management" on the other were integrated, the outsourcing of SAP processing in order to achieve best available services, reflexively turned back on itself and caused the overall quality of the IT services to be rather poor.

When we ended our data collection the SAP installation in HAE had been in operation for only a short period, accordingly the experiences collected are limited. However, there were already signs that indicated that maintenance would be expensive and challenging. For example, an upgrade to a new SAP version has so far cost about 50 mill. NOK.

In the Oil&Gas division the experience has been similar. They have been running a SAP installation for several years. It is a much smaller application than the one in HAE (about 2000 potential users). The implementation was carried out as an incremental process and stretched over a long period. The first projects started already in 1992. In addition, the implementation strategy emphasized using as much as possible of standard SAP functionalities, keeping at a minimum. This was done in order to make the upgrades and maintenance as smooth as possible.

Over the years the SAP installation has become integrated with a large number of other applications, in total 31 internal and external systems are linked to SAP through various interfaces developed ad hoc. All these interfaces have to be maintained for each new version upgrade or error correction in SAP (the implementation of "Hot Packages"- see below). The paradoxical outcome is that the maintenance of the interface between SAP and other systems is more difficult and resource consuming than the maintenance of the interfaces between the old systems. One explanation of this paradox is that SAP is much more sophisticated than the old systems, which makes the interfaces more complex. At the same time, SAP changes more often than any of the old systems, either in terms of new versions released or error corrections. (Given its complexity, the implementation is full of errors). Typically, SAP is subject to rapid change because the huge customer base generates lots of new requirements all the time. Moreover, as its integrated nature implies, when any module is changed, the whole system has to be modified. Thus, in spite of the fact that the number of interfaces to be maintained decreases when an organization installs SAP, their complexity and change rate increase so much that the overall maintenance costs reach very high levels.

In spite of the standard solutions applied, the upgrades of the SAP code itself are also very complex and time consuming. The last upgrade (at the time of writing) enforced the SAP application to be down for 9 days! Also here there are many explanations. For example, when all the work processes are integrated it creates a complex production lattices. Because of many errors in the software all work processes have to be tested extensively, etc.

SAP aims at releasing one "functionality version" each year, and one "correction version" to each "functionality version." The maintenance and corrections of these releases come as Hot Packages. SAP recommends that all Hot Packages should be installed in order to avoid errors in later installations. And they have to be installed in the right sequence. Thus, the Oil & Gas division had installed fifteen Hot Packages, which were supposed to correct 500 errors after seven months of use of one version. People began to question the reliability of SAP. They experienced that the software that was delivered was not finished. On one occasion they had to install 500 " fixes" to one single version. Now, even in the Hot Package there are errors… And because they have to be implemented in sequence, this causes tremendous delays.

We conclude here the interpretation of the empirical evidence guided by the modernity and globalization perspective. While many of the events, breakdowns and deviations could be attributed to human or organizational strategies and errors, we found little evidence of that. Hence, we departed from the explanations in good currency dictated by the managerial perspective, such as lack of leadership;

psychological resistance; wrong implementation tactics. We think instead that the phenomena analyzed in detail transcend the individual company case (we are comforted in this belief by other case studies – see Ciborra et al. (2000)) and are apparitions embedded in the dynamics of modernity and globalization with its side effects.

6. Conclusion

SAP has been implemented in Norsk Hydro as a part of their globalization and re-engineering strategies in order to obtain increased efficiency and managerial control over the business. The plan was that the ERP package should support the integrated, re-engineered organization and then enable further integration. Whether this objective has been achieved after a long implementation process can be debated. To begin with, no change obtained during the re-engineering project. However, SAP generated a new transformation momentum. But after its installation the ERP seems to be a major obstacle for the planned change, because of its complexity, its degree of integration with other systems, and the rapid pace of modification in the industrial code delivered. This has major consequences for the user organization. The firm has to adapt its processes and structures to the modifications in the SAP product at the same time, as the organization is hardly able to adapt the installation to its changing needs. The managerial perspective with its taken for granted emphasis on control has difficulty coming to terms with these surprising outcomes, usually by dismissing them and pointing out the lack of awareness and commitment; the need for tighter control, stronger leadership and better overall alignment of resources.

We have submitted, instead, that understanding the dynamics of modernization and the roles played by globalization and its side-effects opens new venues for a more comprehensive approach. ERP installations in global organizations conform pretty well to Giddens' (1999) image of the modern world as a juggernaut, i.e. a runaway engine of enormous power that, collectively as human beings, we can drive to some extent but that also threatens to rush out of our control in directions we cannot foresee, crushing those who resist it.

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