The problem of agency: how humans act, how machines act

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Abstract

A long-standing debate in the IS literature concerns the relationship between technology and organization. Is it technology that acts on organizations, or humans that determine how technology is used? Proposals for a middle way between the extremes of technological and social determinism have been put forward based on Giddens' structuration theory, and, more recently, from actor network theory. The two theories, however, may be seen to adopt rather different, and potentially incompatible, views of agency (action). Thus, structuration theory sees agency as a uniquely human property, whereas the principle of general symmetry in actor network theory implies that machines may also be actors (agents). This rather fundamental disagreement may be characterized as the problem of agency. At the empirical level the problem of agency was played out in a Canadian telecoms company adopting an ERP system. Was it the mangers and unions (the human agents) that were determining the trajectory of the organization, or did the ERP system also play a role? This paper argues that neither structuration theory or actor network theory offers a particularly convincing account of the interplay of human and machine agency in this case. Since they cannot easily be combined, IS researchers need to develop more convincing theories which are focused on organization and IT. Some guidelines for this development are offered.

Keywords: machine agency, human agency, structuration theory, actor network theory, ERP systems

1. Introduction

Although interest in ERP systems may be motivated, at least in part, by the size of the market for ERP software and the scale of investment required of companies implementing them (Markus & Tanis, 2000; Ross & Vitale, 2001), enterprise systems may also be seen to be significant in terms of the scope of their effect on organizations. In attempting to provide seamless integration of all information flowing through a company, ERP systems are seen as reaching into every aspect of a business, promoting common processes and transforming organization and culture (Davenport, 1998; Kumar & Hillegersberg, 2000). In particular, these systems are sometimes seen as embodying a technological imperative that enforces a standardized model to which organizations must adapt. Thus Ross and Vitale (2001) report that, in a company they studied 'the daily experience of persons actually using the system was that a computer was dictating how they would do things.' 'We are slaves to the systems,' said the company's CEO, 'and we have accepted the technological imperative that that implies.' Davenport (1998:122) argues that 'an enterprise system, by its very nature, imposes its own logic on a company's strategy, organization and culture'. At the same time, however, this logic is seen to be the cause of the widely-publicized failures of a number of major ERP systems. Davenport (1998:131) proposes therefore that the successful implementation of enterprise systems requires a balancing of the 'imperatives of the technology and the imperatives of the business.'

Talk of intrinsic and irresistible 'logics' of the enterprise system, of technological and business 'imperatives' and of technology 'impacts' may be seen to reflect a more general view of the

relationship between technology and organizations. This has traditionally been understood in terms of technological and social determinism (Markus & Robey, 1988). On the one hand, technology is viewed as imposing itself upon a powerless organization; on the other, technology is seen to be shaped by the inexorable requirements of the organization. While to some extent these opposing viewpoints may be caricatures of more subtle positions (Grint & Woolgar, 1997); (George & King, 1991), they nevertheless highlight an issue that would seem central to the IS research endeavor, that is the relationship between the technical and social aspects of IS. This may be characterized as 'the problem of agency', i.e. if agency is 'the capability to make a difference' (Giddens, 1984), then how does technology act upon social systems and vice versa? The technological and social determinist perspectives each offer a simple answer to the problem of agency. For the former, agency is seen as resting solely with technology while for the latter it lies wholly with humans. Clearly, these positions, in their pure form, are incompatible (i.e. if agency is restricted to humans, then machines have no agency and vice versa). Various attempts (e.g. (George & King, 1991; Markus & Robey, 1988; Pinnsonneault & Kraemer, 1993) have therefore been made to suggest a third, intermediate position that could transcend these polarities. In the European tradition (less so in the more dominant American tradition), initial interest was focused around Giddens' structuration theory (Giddens, 1984), while more recently actor network theory (Latour, 1987) has attracted increasing attention. However the treatment of agency in the two theories would seem incompatible. Thus, for Giddens (1984: xxii), agency is synonymous with human actors. Technical artefacts, their enduring materiality notwithstanding, are simply 'allocative resources', equivalent to codes and normative sanctions, that influence social systems only when incorporated in processes of structuration (Giddens, 1984: 33). While the status of material artefacts in Actor-Network Theory is somewhat ambiguous (different authors adopting apparently different definitions at different times), Latour's discussion of the agency of key fobs, door closers, and speed bumps (Latour, 1991); suggests a concept of agency that is not restricted to human actors. Indeed, the coining of the term actant (Latour, 1987) was intended to get away from the association of agency solely with humans.

If IS is taken to be an applied discipline, drawing on other, more fundamental reference disciplines, or a relativistic, pluralist discipline in which many theoretical approaches are welcomed as relevant to different problem formulations, then incompatibilities between reference disciplines may not be a serious issue. However some researchers have more recently argued that IS can develop its own theories which can contribute to other disciplines (Orlikowski & Barley, 2001), or indeed be a reference discipline for other theoretical areas (Baskerville & Myers, 2002). It could therefore be argued that IS researchers should try to move beyond borrowing theories which are targeted at other fields (social theory in the case of structuration theory, science and technology studies in the case of actor network theory) and develop theories which are properly focused on IS concerns; here the relationship between organizations and IT. One possible strategy for doing this is to examine relevant conflicts between reference theories.

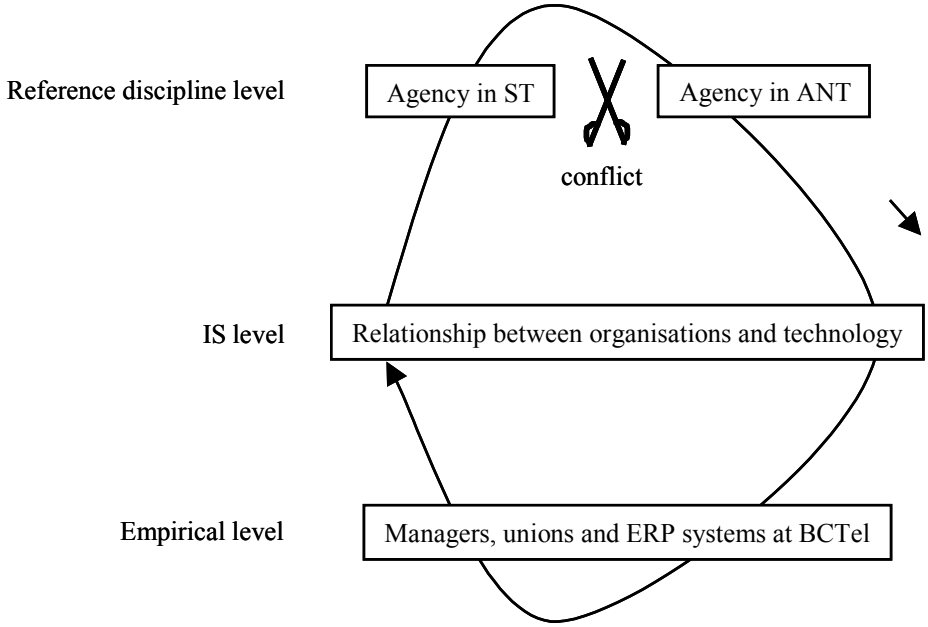
This paper seeks to articulate one such conflict, the problem of agency. The problem is articulated in three ways: at the empirical level (the ERP implementation at BCTel), at the IS level as the relationship between organizational actors and IT, and at the reference discipline level as a conflict between the conceptualization of agency in structuration theory and actor network theory. If it is neither possible to satisfactorily explain agency in the empirical case using ST and ANT, nor to combine the two approaches un-problematically, then an alternative theoretical account of the interaction between human and machine agency, focused on the

concerns of IS, would seem necessary. Some guiding principles for this theoretical account are set out.

2. Research design

The research design employs the study of agency at two theoretical levels (the IS level and the level of its reference disciplines) and the empirical level (Figure 1). The problem of agency is identified through long-standing debates in the IS field. It is further explored through a discussion of conflicting theorizations of agency in two important reference disciplines (structuration theory and actor network theory) and their adaptations to the IS field. This theoretical discussion is empirically elaborated with an interpretive case study. The three levels enable a discussion of possible developments to the theory of agency in the IS field.

Figure 1. research design



2.1 Data collection

Sixteen interviews were conducted between Sept 1999 and March 2000. The interviewees comprised two plant/technical workers, two supply workers, eleven clerical workers and one middle level manager, drawn from the various operational units affected by the ERP system. The TWU leadership was also interviewed. The interviews were face to face with the exception of one telephone interview and lasted between 1 and 1/2 hours. Interview summaries were constructed in the presence of the subjects who had the opportunity to adjust or expand their responses. All interviews were recorded and later transcribed.

The case description was built from the relevant set of data. The construction of a narrative (implying inclusion of some data and exclusion of other, ordering, prioritizing, basic story-telling techniques) is itself a research process. Construction here does not imply falsification, but rather the abstraction of one set of related events and experiences from the data, in preference to the many other competing narratives which are possible. Here the narrative is designed to focus attention on the agency of managers, union officials, workers and the ERP system, and the intended and unintended outcomes of that agency.

3. Human and machine agency: theoretical background

In response to the perceived deficiencies of both the technological and social determinist positions, various attempts have been made to develop intermediate approaches that recognize a contribution from both technological and social factors (Grint & Woolgar, 1997; McLoughlin, 1999). These include socio-technical systems (Mumford), social shaping (Mackenzie & Wajcman) and social construction of technology (Bijker *et al*). Within the IS literature, however, theoretical attention initially focused (Markus & Robey, 1988; Pinnsonneault & Kraemer, 1993) on the 'Web models' of Kling (1982) and structuration theory (Giddens, 1984). Structuration theory has tended to predominate in subsequent studies (Jones, 2000), and has received a sophisticated exposition relevant to the 'problem of agency' in the work of Barley (1986; 1990) and Orlikowski (2000; 1992; 1991).

Barley's (1986) structurational analysis focused on the effects of the introduction of Computed Tomography scanners into the radiology departments of two hospitals, showing how the same equipment lead to quite different social organization in the two, nominally similar, environments. The CT technology was characterized as an 'occasion for structuring', and it was proposed that structuration theory should be seen as a form of 'soft determinism'. This study was extended by Barley (1990) to examine how roles and social networks mediate technology's 'structural effects', arguing that 'technically-driven social change is likely to be rooted in a technology's material constraints', but that these must be transformed into social forces if technology is to have a significant effect on social organization.

Although defining technology as 'material artefacts (various configurations of hardware and software)', Orlikowski (1992:403) claimed that this should not be seen to imply an 'exclusive focus on technology as a physical object'. Rather, she argued, following Pinch and Bijker (1987), technology should be seen as 'interpretively flexible', being 'created and changed by human action, yet ... also used by humans to accomplish some action'. That this is not always recognized in the information systems literature was attributed to the 'time-space discontinuity' of design and use of information systems that 'typically' occur in different organizations (those of the vendor and customer). It was also stated, however, that 'interpretive flexibility is not infinite', being constrained by the material characteristics of the technology and the institutional contexts of its design and use, and the power, knowledge and interests of the relevant actors. Thus 'initial designers of a technology have tended to align with managerial objectives ... with the result that many technologies reinforce the institutional status quo' (p409). This may be associated with the reinforcement politics position discussed by George and King (1991), which suggests that technologies tend to be implemented by dominant groups in organizations in ways that sustain their position. Orlikowski proposed that the influence of technology on social processes occurs through its appropriation by humans. Technology is also, however, 'the medium of human action', conditioning, rather than determining, the performance of social practices. The form and function of a specific technology is thus seen to 'bear the imprint' of the social and historical conditions under which it is built and used and this may reinforce or transform the institutional properties of organizations. For example it is argued that 'when users conform to the technology's embedded rules and resources they unwittingly sustain the institutional structures in which the technology is deployed' (Orlikowski, 1992: 411-412).

While this might appear to provide a solution to the 'problem of agency', as Grint & Woolgar (1997) point out, it retains elements of technological determinism (or as they put it, 'residual

essentialism'), in suggesting that technologies have intrinsic material properties that can have determinate effects on human action. This may also be seen to be incompatible with some key assumptions of structuration theory. Thus, in his attempt to resolve the long-standing division in the social sciences between those who consider social phenomena as products of human agency in the light of their subjective interpretation of the world, and others who see them as caused by the influence of 'objective', exogenous social structures, Giddens (1984) proposed that structure and agency should be viewed, not as independent and conflicting elements, but as a mutually interacting duality. Hence social structure is seen as being drawn on by human agents in their actions, while the actions of humans in social contexts serve to produce, and reproduce, the social structure. In order to achieve this position, Giddens adopts a particular, subjective concept of structure as 'rules and resources, organized as properties of systems'. It is therefore 'a 'virtual order' of transformative relations ... that exists, as time-space presence, only in its instantiations in [reproduced social] practices and as memory traces orienting the conduct of knowledgeable human agents' (Giddens, 1984:17). This is true, Giddens argues, even in the case of the apparently material allocative resources (such as land, or in this case information technology) which 'might seem to have a 'real existence'' but which 'become resources only when incorporated within processes of structuration' (Giddens, 1984:33). Notions of structure being embedded in technology, such as Orlikowski (1992) proposes, are therefore incompatible with Giddens' concept, both because it implies a temporal separation of structure from agency (splitting the duality back into a dualism), but also because it gives the embedded structure an objective character inconsistent with his subjectivist ontology. This would appear to be recognized in Orlikowski's later revisiting of structuration theory (Orlikowski, 2000) in which she proposes a 'practice lens' as a means of overcoming these inconsistencies. While this may bring her position closer in line with Giddens, it does not, unfortunately, provide a solution to the problem of agency as we have identified. Thus, as Monteiro & Hanseth (1996) argue, its subjectivist ontology makes it difficult to account for technology as a material artifact existing independently of social practices and acting upon them, and contributes to the relative neglect of detailed consideration of technology in the IS literature drawing on structuration theory.

More recently another approach has begun to attract considerable attention in the IS literature which pays greater attention to material artifacts and might therefore appear to offer a way out of this impasse, namely actor network theory. Perhaps the central tenet of this theory in this respect is the assumption of 'general symmetry' between the technical and social worlds. In particular, rules of method applied in the one domain should operate exactly the same in the other. The role of human actors should not therefore be privileged relative to non-human actors, such as pieces of hardware or software. Rather, the aim is to identify the configuration of the alternative heterogeneous networks of actors (comprising both human and non-human 'actants') and the way in which they influence the development and stabilization of forms of technology. As Callon and Latour (1992) acknowledge, this assumption brings with it some challenging implications that they are not reluctant to embrace. Thus, if humans and non-humans are to be understood as equal partners in these actor-networks then material agency needs to be considered just as important as human agency. In discussing a French research program to develop an electric vehicle, for example, Callon (Callon, 1987) talked of catalysts that 'refused to play their part' and of hydrogen atoms 'refusing to be trapped by catalysts', alongside engineers from Renault lobbying against the project. IS researchers using this theory base tend to analyze technology or computer systems as material agents or actants. Thus Hanseth (2000) claims that large systems like the internet 'appear as independent living actors.' Hanseth and Braa (2000) speak of 'infrastructures as actors,' of the 'agency' of SAP, and point out that SAP was a 'powerful actor' and an 'ally' in

'getting the change process moving' in the company they studied. As a more complex infrastructure emerges, SAP becomes 'a more independent actor, and 'increasingly resistant to control.' Another distinctive strategy amongst IS researchers is to clearly set out the principle of symmetry, but then to analyze only the agency of the human actors, whilst ignoring the agency of the non-human actors. Holmstrom and Stadler (2001), for instance, assert that 'ANT regards humans and non-human as equally endowed with the power to act;' and that 'technology is an actor because it has been endowed with the ability to act through its position in the network.' However, in their analysis of the failure of the Swedish electronic cashcard, they analyze almost exclusively the interests of the human actors: banks, merchants, customers, technology providers, users etc, effectively ignoring the agency of the technology. Here the technological artefacts are clearly *components* of the networks described; how (and whether) they *act* is unclear.

For Schaffer (1991), ANT's strong conception of material agency is not tenable. Latour's suggestion that actants (including material actors) have 'actions…..subjectivity…intentionality……morality' (Latour, 1999) constitutes 'hylozoism, an attribution of purpose, will and life to inanimate matter, and of human interests to the nonhuman'. Pickering (1995) also notes that, in practice, the treatment of material agency by Callon and Latour (Callon, 1991; Callon & Latour, 1992) generally involves a shift to a domain of semiotic analysis, which sees agency as operating in the realm of texts and interpretations. Interestingly, as Grint & Woolgar (1997) note, strong symmetry also does not entirely eliminate essentialism. Thus, for example, Callon's analysis of the electrical vehicle program relies upon assumptions about the particular properties of catalysts to explain the dissolution of the actor-network. Moreover, in explaining the persistence of particular actor-network configurations, Callon (1991) talks of the irreversibility of techno-economic networks while Latour (Latour, 1991) describes technology as 'society made durable'. This may be seen to echo the notions of embedded structure criticized above. In treating the social and technical symmetrically, therefore, actor network theory may be seen as attributing capabilities to technology which are considered to be properly human, thereby diminishing the potential for human agency. Although such a position may be a useful corrective to the neglect of technology in traditional and structurational accounts (Monteiro & Hanseth, 1996) strong symmetry would only seem semiotically sustainable. In practice, humans and machines are not equivalent, even if both deserve proper consideration in understanding the design and use of information systems.

The next section examines the problem of agency at the empirical level.

4. ERP at BCTel

4.1 Background

At the time of the research the telecommunication industry worldwide had been undergoing rapid change. Regulatory changes and increasing consolidation of markets and providers had encouraged a wave of mergers and takeovers, and the industry's traditional focus on the provision of telephone services, was giving way to emerging business models that viewed bandwidth as a commodity supporting many additional digital services. The Canadian telecoms market reflected these developments with increased competition, regulatory change and alliances and mergers. Responding to these pressures, Canadian telecoms companies sought to rationalize work processes and internal information systems, with many, including the British Columbia Telephone Company (BCTel), adopting ERP systems as their preferred solution.

Historically, technology change in the Canadian telecoms industry, and at BCTel had been marked by significant labor disputes (Bernard, 1982). Technology advances had often been driven by managerial requirements for automation, with consequent reductions in the workforce. In the years immediately prior to the adoption of ERP, however, the process of new systems development at the company had become more consultative. For the two previous large-scale developments, for example, teams comprised of representatives from management, developers and user groups were assembled for the life of the project, from requirements determination through implementation, installation and training. These systems were adopted by users and considered successful. The union had negotiated rights of notification regarding the planned implementation or adoption of new technologies.

4.2 Case outline

Managers at BCTel decided to replace legacy systems with SAP in July 1996, despite anticipating opposition from the TGU (the Telecommunication Workers Union). The system went live in June 1998. The implementation was the occasion for many operational difficulties, process re-organization and redundancies. According to union officials, BCTel managers used the implementation as an opportunity to reduce the influence of the union. SAP then became a major factor in the company's subsequent merger in June 1999 to Telus Alberta. It was argued that the merger was feasible because both companies were SAP users. However, the two company's versions of SAP were not easy to integrate. The TGU won the election to represent the workforce in the new company, which was named Telus.

The outline dates for the case are given in Table 1. The narrative is focused around three key points in the story: the ERP adoption decision, the ERP implementation, and the merger with Telus.

January-March 1995	SAP assessment and opportunity
March-May 1996	SAP planning and business case
July 1996	BCTel Board decides on SAP
July-September 1996	SAP implementation started
March 1998	unions informed of implementation
June 1998	SAP(v. 3.1H) go-live
November 1998	merger talks
February 1999	merger announced
June 1999	merger with Telus of Alberta (new company name Telus)
March 2000	abandon SAP big footprint
May 2000	union representation vote, TGU wins
January 2001	consolidation of SAP and upgrade to version 4.6B

Table 1. Sequence of events at BCTel

4.3 The ERP adoption decision

In January 1996, following an assessment/opportunity study in the second quarter of 1995, a planning committee of BCTel laid a proposal before the Board of Directors to implement an ERP system. Several factors were identified as motivating the proposal. Chief among them were the looming threat of the millennium bug and the need for better systems interoperability. There

were judged to be thirty-five critical systems with hundreds of sub systems all needing some form of Y2K retrofitting.

"For us it would be the biggest because most of the systems that we had, some of them were 25 - 30 years old, and they were all written either in Cobol or they were written in other old machine languages that definitely were not Y2K compliant, they were all into the 2 digit."

Middle Manager, interview, 30 September 1999

In addition, while these systems were, in the main, stable, functional and well-liked by the work force, they operated effectively as separate 'islands of automation'. A further element in the decision was that the Canadian industry was standardizing on SAP, and that the future of the industry was expected to be rationalization through mergers. The implementation of an ERP system was expected to solve both the Y2K and integration problems simultaneously, as well as providing an infrastructure platform with common data models and process models upon which to base later system development. Funding for the ERP project was to come, in part, through head count reductions. It was decided to adopt a "large footprint" approach to SAP adoption, with nine different modules being implemented simultaneously. Moreover, rather than choose either to make organizational changes in advance of the systems implementation or to customize modules to the work practices of the existing organization, the Board decided to adapt the organization to the 'best practice' business processes of the ERP system.

"you get one that's already built that's got that large footprint that can take those various pieces of information and deal with it, maybe in a different way, and that's what happened to our business plan within BCTEL because we had to adapt within the SAP framework"

Middle Manager, interview, 30 September 1999

Breaking with the earlier consultative approach, the SAP project proceeded using outside contract developers and management classified personnel only. The project had thus been under development for 18 months before the union was notified of the impending system in March 1998, only a few months before the 'go live' date of 1 June 1998. The union quickly identified the new IT system as a threat to their interests, and mounted a vigorous campaign of resistance and negotiation. Amongst union activists, the SAP system acquired the nickname of the 'Armageddon machine'; the machine that would lead to the destruction of the union's interests. The union was powerless to stop SAP, and the implementation plan was adhered to:

"a political decision was made that the particular time frame will be met, I think it was June 1st and there was no backing off of that and I don't think anybody was ready for it, but come June 1st it {SAP} was in."

Middle manager, interview: 30 September 1999

4.4. The SAP implementation

The early stages of the implementation were characterized by initial confusion and dysfunction

"The first year of implementation was hell because they forgot a lot of the flows and processes and even overlooked whole internal routines so there was a lot of human intervention to make the system work. We could put products in our warehouses but we couldn't take them out."

Union official, interview, August 16 1999

Union officials perceived that the ERP system allowed managers to reorganize workflow.
It was clear that the effect that the implementation of SAP on work process had not been thought out in advance by managers.

"The point was put across basically that there was no choice, and if there is no choice of implementing the system you work with it. That was one of the major downfalls I think with the implementation of SAP (was) even the people that were implementing it and putting it together didn't realize the impact it would have throughout the company. They would know that there would be an impact but they didn't know how much it would impact, they didn't know how much training was going to be required, they didn't know how it was going to make people have to adjust the way they did business decisions or how they did their day by day, it's just a fact that we had to have the system in place and we went forward from there."

Middle manager, interview, 18 August 1999

Managers and staff worked hard (often with many hours of unpaid overtime) to devise workarounds, adjust processes, and tune the SAP system, in order to restore service levels to customers. With the SAP system installed, work flows changed considerably. For example, before the adoption of SAP, order placement required engaging three separate application systems and a hand off to several persons responsible for scheduling, inventory, accounts approval, engineering and the like. In the post-ERP environment a single person handled all functions within SAP. Unusual customer requests, however, that had previously been handled by staff making on-the-spot decisions within certain guidelines, were now blocked by the system. After an initial surge in work as data needed to be captured and recoded and as workers and management alike struggled to understand and adapt to the new system, downsizing began in the areas of accounting and finance. The accounting function was subsumed in a (now greatly enlarged) finance operation. General reductions were also found in a number of other areas.

"Everybody else from my department was gone, they were all surplussed, one girl got pulled back and she did the financial schedules……"

Union official, interview, August 18 1999

Many of these organizational changes lead to significant changes in power relationships between management and labor. In some administrative departments, for example, the ratio of union workers to managers, that had been 12:1 prior to ERP implementation, was reversed to 1:5, as staff were hired to newly-defined technical and managerial positions rather than traditional job titles covered under the collective bargaining agreement. However, there were also some management redundancies.

"the funny thing is SAP will make the decisions for you, so you don't need as many managers. Of course, the corporate scenario North America wide is reduce."

Union official, interview, August 18 1999

4.5 The merger of BCTel and Telus of Alberta

Reflecting trends in the industry worldwide, BCTel began in November 1998 to explore the potential for allying with other regional telecommunications firms in Canada and in June 1999 merged with Telus of Alberta. The new company is named Telus Canada. The merger was primarily promoted on the basis of expected savings and economies of scale (arising in part from a further headcount reduction), but one factor that was assumed would facilitate the integration was that Telus was also an SAP R3 user. In practice, however, this proved far from straightforward as their SAP implementations were very different.

"if you look at the mapping that they've done and how they use SAP that's on the Telus side, it's very, very different than the way we use it. Very different. I'm not saying which one is right or wrong."

middle manager, interview, 30 September 1999

On the one hand, Telus-Alberta had chosen a highly customized (configured) implementation of a limited set of modules. BCTel, on the other, had opted for the 'big footprint' approach described earlier. Moreover each firm had a slightly different version of the product: SAP v3.1H in the case of BCTel, SAP v3.1I in the case of Telus Alberta. A further complication was added by the decision that the merged company should migrate from the SAP R3 to the newer version 4.6. This substantial product upgrade turned out to be almost as difficult as the original implementation. The net result was that the ERP system, originally perceived as facilitating integration, proved to be an obstacle. In the end it was decided to adopt the Telus configuration (effectively abandoning much of the BCTel work). Nevertheless, configured or un-configured, SAP made an impact

> *"It's always been the SAP way. We configured it as much as we could to make it as close to what we had before but we've actually changed our ways big time with SAP to make it the SAP way. Both companies had to do that."*
>
> Middle manager, interview, 30 September 1999

The Telus Alberta workers had traditionally been represented by the IBEW (International Brotherhood of Electrical Workers), which had generally been more accommodating to management intentions. With TGU union power subdued by organizational re-structuring and IBEW eschewing militancy, company managers expected little worker resistance to the merger. However, attitudes had hardened.

> *"our perception of this whole SAP thing is that, they {managers} already had numbers of where they were going to knock people out - bargaining {union} people, downsize, we want these many people gone, so this is going to save us some money, this is our cost savings"*
>
> clerical worker, interview, 29 September 1999

In the union re-authorization election for the new company, the TWU exploited the provisions of its labor contract and the sets of rulings on technology change as part of its campaign. They argued greater experience with, knowledge of and protection against the ERP system and won the election, replacing the more docile IBEW. The resurgent TGU negotiated protective terms for workers, which partially protected them against further management rationalizations.

5. Discussion

5.1 Human and machine agency at BCTel

Here we analyze human and machine agency at three key points in the story: the adoption decision, the SAP implementation and the merger. The primary human agents are managers and union officials (acting on behalf of the unionized workforce), and the (candidate) machine actor is the SAP system.

At the adoption decision, the focus of agency lay with the managers and the unions. Managers decided to adopt SAP, without telling the union, in response to their own agenda and perceived problems. These included legacy systems which did not communicate, poor aggregation of information and the Y2K problem. Managers attributed to SAP the power (agency) to solve these set of problems, assuming that the machine would have beneficial, if unspecified, consequences ("*you've got a system that's new and you've got a process that's new and hopefully the process is more streamlined so therefore you have again that productivity*"). However, they acknowledged SAP's power to dictate work practice, and therefore to cause disruption to established patterns. Hence the plain vanilla large footprint decision – essentially an attempt to get the mismatch between SAP practices and BCTel practices over with in one short, sharp

shock. Mangers excluded the union from the decision making process and subsequent preparations as long as possible, in the hope that the project would be in place before unions could muster enough resistance to stop or delay it. Union leaders attributed (ultimate) agency to the machine also, seeing it as the bringer of final destruction, the Armageddon machine. This characterization may have been in part the result of their historical experience, resulting in a tendency to demonize new technologies, in part an attempt to influence how others interpret the agency of the machine. Although the Armageddon machine characterization was (with hindsight) exaggerated or mistaken, it clearly fed into the union officials response to SAP. They foresaw serious threats to workers' interests, regarding the managers and the SAP system as allies, and acted to contest the decision.

Whereas the managers (resisted by unions) were the principal agents in the adoption decision, at the implementation the inexorable 'logic' of ERP identified by Davenport (1998) would seem very much in evidence. Whereas, in the past, the prime goal of a software development project might have been to fit the shoe to the customer's foot, with ERP the customer is forced to reshape his foot to the ERP shoe. SAP at first failed to become part of the existing network; its 'capacity to make a difference' was extensive and necessitated a great deal of 'repair' (Collins & Kusch, 1998) by the human agents. Those using the system must decode, or de-scribe the designers' intentions, and change there own tasks *("how they did their day by day")* to accommodate. Where this does not make sense, they must reinvent tasks in such a way to create the data that the system demanded. This can variously be describes as bricolage (Ciborra, 2000), or RAT (repair, attribution and all that) (Collins & Kusch, 1998). Managers (at least according to union officials' accounts) opportunistically marshaled SAP's rationalizing potential to manipulate the balance of power between management and labor. As the workforce was reduced, union members were 'surplussed' and replaced by non-union jobs. However SAP demands a kind of virtual management in which highly centralized functions must be performed at a terminal by persons of sufficient rank and authority. Where the human actors were the principal actors in the adoption decision (managers deciding, unions resisting), the machine is the principal agent (enactor of change) in the implementation period.

In the next cycle of the story, managers aimed to marshal ERP agency to achieve the merger with Telus. Further job reductions, rationalization and consolidation were expected to result. Since SAP was common to both companies, managers attributed to SAP the power to enable the merger, assuming that the assimilation of data and information systems would be simple and that both companies' processes would already be aligned around "*the SAP way*." In practice, the managers' assumptions turned out to be simplistic. Conflicting implementations of SAP (reflecting earlier managerial agency) resisted managers' intentions and could not be easily integrated. Migrating to version R4 made the situation even more complex (new releases are un-configured, and configuration has to be thought out again), instead of solving the integration problems. Much of the earlier work at BCTel (adjusting to SAP) had to be abandoned. Managers decided to adopt the Telus configuration of SAP, which necessitated further changes in processes in the part of the organization that was formerly BCTel, essentially dictated by the structure of the Telus configuration. These decisions can be seen as the unforeseen consequences of the earlier interaction of human and machine agency. There were further disruptions and more job losses. One unanticipated side effect was a change in union workers' perceptions of the kind of stance they require from their representing union resulting from many uncomfortable personal histories. The result was a more militant line in the union elections for the new company, resulting in a stronger mandate for the TGU, giving them a better bargaining position and the

ability to negotiate some further protection for their members. From the managers' point of view, this could be seen as an unintended, and undesirable consequence of their marshalling of ERP agency.

Where it is clear that managers and unions exerted agency in the ERP story at BCTel, and that the SAP system also shaped what happened (particularly at implementation), it is also clear that these processes interacted. The exercise of managers' agency, unions agency and machine agency was interwoven over time, and each was dependent upon the other. Furthermore, each new step that the management and unions took was dependent on their perceptions of the outcomes of previous agency, both their own and SAP's. SAP was a year 2000 problem solution to managers, the Armageddon machine to union leaders; their actions were partly dependent on their interpretations of the computer system, and how it would affect their futures. The agency of the human designers of SAP should also be acknowledged: their design choices conditioned the technical options open to implementers. Thought the original designers had no knowledge of, or intentions towards BCTel, in theory each of their design choices was reversible, and adaptable to the local conditions at BCTel. In practice these choices are temporally and geographically so inaccessible (there is really no option to reprogram SAP) as to be irrelevant.

5.2 The problem of agency

With these discussions in mind, we are now able to characterize 'the problem of agency' with which this paper is concerned. At the reference discipline level, structuration theory and actor network theory offer different and conflicting theorizations of agency, in line with their different agendas. In structuration theory only humans can be agents, whereas in actor network theory both humans and material objects can be agents (actants), and (in principle at least) technical and social actants should be treated symmetrically. The machines are admitted to the stage and become symmetrical with humans in the formation of networks. They enroll, translate, delegate, inscribe and so on. However, achieving this involves attributing to machines properties of agency which are more properly the preserve of humans. Here the machines achieve a dubious equality of agency with humans which masks their different characteristics. ANT also offers an account of the interwoven nature of human and material agency in the formation of networks whereas in structuration theory, material objects are resources employed by human agents in the process of structuration.

When these reference theories are taken into the domain of IS and used to explain the agency of organizational actors and machines (here constellations of hardware, software and communications technologies that constitute organizational computer systems), different problems result. In true structurational accounts of IS (such as Orlikowski (2000)) the enduring materiality and power of the machines, and their consequent capacity to affect future outcomes, is unacknowledged. The machines are, in effect, relegated to the status of props and tools for knowledgeable human agents. Where the reverse is true (in the adaptive structuration theory of DeSanctis and Poole (DeSanctis & Poole, 1994) and, to a lesser extent, the earlier work of Orlikowski) there are difficulties reconciling the accounts with Giddens' intentions. In actor network accounts of IS, the materiality and constituting nature of computing infrastructures, large software programs and technological artefacts is located more centrally, in their role in the formation of networks. However the issue of how exactly machines act, in relation to their human counterparts, is left unresolved, with the implication that there is little specified difference.

At the empirical level, in the case of BCTel, it is of course possible to tell an ST story, in which the ERP system is a resource employed by managers, and an ANT story in which the actants 'union', 'management' and 'ERP system' are translated into a network. We would suggest, however, that neither of these accounts satisfactorily explain the complex, emergent interplay of different forms of agency evident in the discussions above.

6. Conclusions

When IS field is disparate, with contributions from many reference disciplines, and little fundamental agreement upon ontological and epistemological premises, in Whitley's (1984) terms a 'fragmented adhocracy.' Calls to try to move beyond this position usually involved a better shared repertoire of focused theoretical understandings. We have argued that one way to try to achieve a common repertoire of theoretical understandings is to identify problems at the reference discipline level, in this case ST and ANT, and then try and provide theoretical resolutions which are focused (unlike the reference disciplines themselves) on IS concerns. Here these concerns are the relationship between technology and organisation (more precisely organisational actors). In this paper we articulate the problem of agency at three levels, the level of the reference disciplines, the IS level and the empirical level. Whereas the problem of agency needs no solution at the reference discipline level (the two theories have different agendas) and empirical stories speak for themselves, we conclude that it would be sensible to try to work towards shared theoretical understandings of human and machine agency at the IS level. These understandings would be capable of explaining the ERP story at BCTel without reference to other disciplines. What would the characteristics of such a theory be? An IS focused resolution of the problem of agency should acknowledge both the agency of machines and the agency of humans, but also recognize that they are different. In as much as machines can act and can do so relatively (and increasingly) autonomously, and that their actions have intended and unintended consequences, they do possess agency. Many of those actions, but not all, are either intended or at least anticipated by the machine's designers. However, those design decisions may be so far away in time and so difficult to remedy, that the human designers have become irrelevant in the story. If people do not perceive it to be possible to alter the machines they work with, then the machines have become autonomous at least in the sense that they are as they are, and their design history has become irrelevant. In addition it is impossible for the designers of the machines to foresee, or in many cases even understand, all the sets of conditions they will be used under, or the decisions of the humans who supervise and work with them. Machine agency, however should not be understood as equivalent to human agency. Many of the components which are central to human agency (such as self awareness, social awareness, interpretation, intentionality and the attribution of agency to others), are not normally available to machines. Next we conclude that the exercise of agency, whether machine or human, cannot be understood in isolation from the situational conditions which both make it possible, and frame its subsequent interpretation. Here we concur with Giddens that social structures, made up of individuals' personal experiences are important to understanding, but admit, with Callon, that material components of existing networks can also form part of the situation in which agency is exercised. The exercise of agency (through its intended and unintended consequences) partially constitute the set of conditions under which the future exercise of agency is carried out. In this emergent process, machine and human agency can be found inextricably intertwined: a double dance of agency. Humans base their actions on complex interpretations of past actions and present conditions, and on attributions of agency to machines. Those actions are partly planned, partly opportunistic; partly pro-active, partly re-active to conditions; partly successful, partly

unsuccessful; part strategic oversight, part bricolage and tinkering. Machines (in this case computer systems) also play in important (but different) part in the double dance. Machines facilitate and enable some parts of the human exercise of agency, but constrain other parts. Seen more from the standpoint of their own agency, they accommodate some human purposes, but resist others. Humans try to marshal the agency of machines to serve their own purposes, but cannot always anticipate or control the consequences. Outcomes are emergent from the interaction of both forms of agency, not from one alone.

Weaving these observations into a defensible theoretical model is, luckily, the subject of different paper.

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