The Double Dance of Agency: a socio-theoretic account of how machines and humans interact

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Abstract
The nature of the relationship between information technology (IT) and organizations has been a long-standing debate in the Information Systems literature. Does IT shape organizations, or do people in organisations control how IT is used? To formulate the question a little differently: does agency (the capacity to make a difference) lie predominantly with machines (computer systems) or humans (organisational actors)? Many proposals for a middle way between the extremes of technological and social determinism have been put advanced; in recent years researchers oriented towards social theories have focused on structuration theory and (lately) actor network theory. These two theories, however, adopt different and incompatible views of agency. Thus, structuration theory sees agency as exclusively a property of humans, whereas the principle of general symmetry in actor network theory implies that machines may also be agents. Drawing on critiques of both structuration theory and actor network theory, this paper develops a theoretical account of the interaction between human and machine agency: the double dance of agency. The account seeks to contribute to theorisation of the relationship between technology and organisation by recognizing both the different character of human and machine agency, and the emergent properties of their interplay.

Keywords: agency, structuration theory, actor network theory, human-machine interaction, technology, organisation

1 Introduction

The nature of the relationship between information technology (IT) and organizations - does IT itself shape organizations, or are people in organisations able to control fully how IT is used? - has been a long-standing question in the Information Systems (IS) literature. It underlies debates on topics such as the effect of IS on middle management (Levitt & Whisler, 1958, George & King, 1991), the potential of Business Process Reengineering (Hammer, 1990; Strassman, 1994; Davenport, 1995), the effects of technical standards on IS practice (Ciborra, 2000; Hanseth and Braa, 2000), and the technological and business imperatives of ERP (Enterprise Resource Planning) systems (Rao, 2000; Davenport, 1998). The two extreme positions on this question are

those of technological and social determinism. On the one hand, IT is viewed as imposing itself upon a powerless organization; on the other, IT is seen to be entirely malleable to the inexorable requirements of the organization. While to some extent these opposing viewpoints may be caricatures of more subtle positions (Grint and Woolgar, 1997); (George and 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. Various attempts (e.g. (George and King, 1991; Markus and Robey, 1988; Pinnsonneault and Kraemer, 1993) have been made to suggest a third, intermediate position that could transcend these polarities. Initial interest was focused around Giddens' structuration theory (Giddens, 1984), while more recently actor network theory (Latour, 1987) has attracted increasing attention. These developments have served to focus attention upon agency (in relation to structure in ST; as an actant's role in the formation of networks in ANT). However the treatment of agency in the two theories is incompatible (Rose et al., forthcoming; Rose et al., 2003). Thus, for Giddens (1984: xxii), agency relates exclusively to human actors. Technical artifacts, 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 artifacts 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 (for the purposes of this article we make no conceptual distinction between action and agency, or actor and agent).

This theoretical disagreement may be described as 'the problem of agency' (Rose et al., forthcoming; Rose et al., 2003). If agency is 'the capability to make a difference' (Giddens, 1984), then can machines also exhibit forms of agency, what is the difference between human and machine agency, and how do the two forms of agency interact to produce outcomes? In broader terms: 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). Although these pure forms are seldom found in the IS literature, and most commentators find ways of balancing human agency (typically managerial decision-making) and machine agency (typically technology impacts), there is no convincing theoretical account of the relationship between the two forms of agency. Critiques of structuration theory and actor network theory in the sociological and science studies literatures, it will be suggested, may provide some possible avenues for the development of an account that recognises both the different character of human and machine agency and the emergent properties of their interplay.

Whilst the development of a consistent account of the relationship between IT and organisations would seem an important exercise in its own right, it may also be seen as contributing towards remedying what Orlikowski & Iacono (2001) identify as the IS field's under-theorization of the IT artifact. In particular, it seeks directly to provide insight on 'the meanings, capabilities, and uses of IT artifacts, their multiple, emergent and dynamic properties, as well as the recursive transformations occurring in the various social worlds in which they are embedded', described by Orlikowski & Iacono (2001:133) as 'key unresolved issues for our field'.

The paper sets out to discuss the different standpoints of structuration theory and actor network in relation to agency, and analyse how those theories have been employed by IS theorists and commentators. Understanding of a particular IS viewpoint on the interaction of human and machine agency is enhanced by using some recent contributions dealing specifically with facets of human and machine agency to critique the two theory bases. These understandings are brought together in a new theoretical account of the interaction of human and machine agency, 'the double dance of agency,' and some implications of the theoretical model are discussed.

2 Research method

This paper reports part of a study which is both theoretical and empirical in nature. The empirical part of the study concerns the study of ERP system implementations in organisations (Hørlück et al., 2001; Rose et al., 2003; Kræmmergaard and Rose, 2002; Rose and Kraemmergaard, 2002; Truex, 2001). ERP systems are thought to have wide reaching consequences for organisations, and thus provide good empirical situations for the study of the interaction of technology and organisations. Although the empirical studies have made a significant contribution to the development of the theoretical model, they are not reported in this paper in order to make space for the theoretical arguments.

The theoretical study is designed as follows. The two reference theories (structuration theory, actor network theory) are studied in relation to human and machine agency. Some relevant independent critique of the theories is also studied at the level of the reference discipline (social theory, science studies) to expose theoretical discussions in these fields. The two theories are compared to reveal differences in their conceptualization of agency. Usage of the theories in the IS field is also studied; it is assumed that these adaptations reveal something of the way of thinking and priorities of IS theorists. In particular in the case of the better-developed structuration literature strand, the contributions are analysed in terms of how faithful they are to Giddens' original ideas. The two theories are further investigated by means of a critique based on some relevant contributions to the study of aspects of human and machine agency. Major theoretical insights taken from both traditions and as a result of the comparison and analysis are combined in the theoretical model: the double dance of agency.

3 Agency and technology in structuration and actor network theory

Various attempts to develop intermediate approaches that recognize the contribution of both technological and social factors (McLoughlin, 1999; Grint and Woolgar, 1997) have been made in response to the perceived deficiencies of extreme technological and social determinist positions. 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 and Robey, 1988; Pinnsonneault and 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 (1991; 1992; 2000). More recently a number of IS studies using actor-network theory have emerged (Walsham, 1997; Walsham and Sahay, 1999; Vidgen and McMaster, 1996; Monteiro, 1998; McMaster et al., 1999), partly in response to Monteiro and Hanseth's (Monteiro and Hanseth, 1996) call to be 'more specific about the technology.'

3.1 Agency and technology in structuration theory

Agency, in Giddens' formulation, is the 'capacity to make a difference' (Giddens 1984 pp 14) which he also calls 'transformative capacity'. It is intimately connected with power; in fact this is one of its defining characteristics, since the loss of the capacity to make a difference is also powerlessness. In practice, human agents almost always retain some transformational capacity, though it be small. Power involves the exploitation of resources. 'Resources ……. are structured properties of social systems, drawn on and reproduced by knowledgeable agents in the course of interaction' (Giddens 1984 pp 15). Resources are 'of two kinds: authoritative resources, which derive from the co-ordination of the activity of human agents, and allocative resources, which stem from control of material products or aspects of the natural world' (Giddens 1984).

However agency in structuration theory is inseparable from its mutually constitutive duality with social structure: agency is shaped by structure, while structure is produced, and reproduced, by the actions of humans in social contexts.

> *'Social practices are accomplished by knowledgeable human agents with 'causal powers'' i.e. powers to make a difference……..In producing social practices, which make up the visible patterns which constitute society, actors draw upon 'structural properties' (rules and resources)' (Clark, 1990)*

Giddens argues, however, that agency does not determine the production and reproduction of structure because of unacknowledged conditions and unintended consequences of intentional action. This emphasis on 'mutual shaping' has sometimes been seen as offering an alternative to technological or social determinism (Pozzebon and Pinsonneault, 2001; Markus and Robey, 1988). In order to enable the structurational cycle, however, Giddens' theorizes a weak ('loose and abstract' (Thompson, 1989)) notion of structure as 'rules and resources recursively implicated in social reproduction' which 'exist only as memory traces' (Giddens, 1984). Material objects (such as IT) are not, therefore, in themselves structural. Material resources which 'might seem to have a 'real existence', ……become resources only when incorporated within processes of structuration' (Giddens, 1984:33). The duality of structure and agency is therefore seen as 'a 'virtual order' of transformative relations' ... where structure '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). Technology, from a strictly Giddensian viewpoint cannot be an agent, and can only exhibit 'structural properties' when utilized as a resource in social practice by human agents. As Giddens puts it, 'technology does nothing, except as implicated in the actions of human beings' (Giddens and Pierson, 1998).

3.2 Structuration theory in IS

Notwithstanding this virtual view of structure, a number of attempts have been made to develop structurational analyses of IS that relate to the 'problem of agency,' notably by Poole and DeSanctis (1984), Barley (1986; 1990) and Orlikowski (1991; 1992; 2000). These contributions display varying degrees of faithfulness to Giddens' virtual duality of structure and agency as outlined above. Adaptive Structuration Theory (DeSanctis and Poole, 1994) postulates that structure is inscribed into technology. This happens during the process of construction, with the finished product later influencing the behaviour of its users: 'designers incorporate….structures into technology…….once complete the technology presents an array of social

structures……technology structures…trigger organizational change' (DeSanctis and Poole, 1994). This account (though reflecting a common understanding in the IS literature) is clearly incompatible with Giddens intentions, both because it locates structures inside technology, and because it then implies that the technology 'does something' (triggers change), i.e. displays agency. Barley (Barley, 1986) also considers technology to be structural, examining how roles and social networks mediate technology's 'structural effects.' In Barley (1990) he further argues that 'technically-driven social change is likely to be rooted in a technology's material constraints' (here structure ('constraints') and agency ('driven') are conflated), but that these must be transformed into social forces if technology is to have a significant effect on social organization. Orlikowski's structurational model of the 'duality of technology' (Orlikowski, 1992) goes somewhat further in explicitly introducing material technology into the structure/agency duality, also suggesting that social rules may be 'embedded' in IS during their design, but insisting that they cannot be programmatically read off by humans in a determinist manner (interpretive flexibility). The influence of technology on social processes, according to Orlikowski occurs through its appropriation by humans. Technology is also, however, 'the medium of human action', enabling some actions whilst constraining others, but 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). Unfortunately, as she herself acknowledges (Orlikowski, 2000), this is 'problematic', because it 'ascribes a material existence to structures which Giddens explicitly denies'. Orlikowski later develops a 'practice lens' (Orlikowski, 2000), whereby technology structures are seen as 'virtual, emerging from people's repeated and situated interaction with particular technologies.' This can be seen as the theoretical account most consistent with Giddens' intentions (though this of course says little about its value to the IS community). While this account may go some way towards incorporating technology into a truly structurational perspective, it does not entirely overcome the criticism of Berg (Berg, 1998) that structurational analysts unduly privilege human agency, causing 'technology to vanish from their accounts, appearing only as an occasion for structuring, without any activity or specificity of its own.'

3.3 Technology and agency in Actor Network Theory

A central tenet of actor network theory, in contrast, is an assumption of 'general symmetry' between the technical and social worlds, in which no a priori distinction is made in the treatment of human and non-human actors. Rather, the aim is to understand the development and configuration of 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. Technological artifacts (such as IT systems) acting in networks are often referred to as machines. Its appeal for IS researchers wishing to provide a balanced account of agency, but also to 'take technology seriously' (Monteiro and Hanseth, 1996), may therefore be evident. ANT's primary focus may be said to be the formation of such heterogeneous networks, and Grint and Woolgar summarize it as a process:

> *'The actor network is configured through the enrolment of allies (both human and non-human entities) into a network by means of negotiations. This process of 'translation' involves four relatively discrete moves. First the 'problematization' stage identifies key*

actors who are then persuaded that the solution to their own problem lies with the enrollers. Second, intéressement involves the gradual dissolution of existing networks and their replacement by a new network created by the enrollers. Third, the stage of enrollment proper occurs, in which, through coercion, seduction or consent, the new network achieves a solid identity. Finally the alliance is 'mobilized' to represent an even larger network of absent entities' (Grint and Woolgar, 1997)

In this process, actants are defined 'by what they do.'(Latour, 1987). In actor network theory, agency is not restricted to humans, but is attributed to technologies ('machines') and to material objects more generally. Moreover, human and machine (or material) agency are sometimes considered equivalent: 'the term actant is symmetrical, it applies indifferently to both humans and non-humans' (Latour, 1991). 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.

For Schaffer (1991), ANT's strong conception of material agency is not tenable. Latour's suggestion that actants (including material actors) have 'subjectivity…intentionality……morality' (Latour, 1999) constitutes 'hylozoism, an attribution of purpose, will and life to inanimate matter, and of human interests to the nonhuman'. One may also question in what sense material objects problematize, intéresse, enrol, mobilize. Pickering (1995) also notes that, in practice, the treatment of material agency by Callon and Latour generally involves a shift to a domain of semiotic analysis, which sees agency as operating in the realm of texts and interpretations. Nor, as Grint & Woolgar (1997) note, does strong symmetry necessarily eliminate essentialism. Although the ANT position may be a useful corrective to the neglect of technology in traditional and structurational accounts (Monteiro and Hanseth, 1996), in the discussion of agency, strong symmetry would only seem semiotically sustainable. ANT theorists also recognize this when they describe an actor as 'an actant endowed with a character' (Akrich and Latour, 1994). In practice, human and machine agency is not equivalent, even if both forms deserve proper consideration in understanding the design and use of information systems

3.4 Actor Network Theory in IS

IS researchers using ANT analyze technology (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.' However, a distinctive strategy amongst IS researchers is to clearly set out the principle of symmetry, but then to concentrate upon 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 cash card, they analyze almost exclusively the interests of the human actors: banks, merchants, customers, technology providers, users etc, effectively ignoring the agency of the technology; indeed it is not clear in what sense a technology can be said to have 'interests'. Similarly Pouloudi and Whitley (Pouloudi and Whitley, 2000)

demonstrate how '[human] stakeholders attributed different values and interests to the non-human stakeholder……the encryption algorithm,' rather the consequences of the actions of the algorithm. Here the technological artifacts are clearly *components* of the networks described; how (and whether) they *act* is unclear.

Thus, while both structuration and actor network theory may have made valuable contributions to understanding information systems, they offer different and incompatible theorizations of agency/action, each of which has its strengths and limitations. In structuration theory, agency is primarily related to social structure, making it impossible to ignore the social conditions under which technology operates. However in ST, technology's agency, its capability to 'make a difference' is unacknowledged; it is relegated to the status of an inert tool employed by knowledgeable human agents. IS theorists adapting ST have understandably chosen to allot technology more influence than Giddens does. In actor network theory agency (acting) is inherent in the process of network formation and stabilization. Here technology (the machine) becomes an independent actor in its own right, but little distinction is made between machine agency and human agency. IS theorists use ANT to promote the influence of technology, without necessarily wanting to attribute anthropomorphic properties of agency to machines. A consistent theoretical account of the agency of machines and humans, therefore, cannot simply combine the two theories; however a critical analysis of their insights may enable such an account to be constructed.

3.5 Critical analysis: agency in structuration and actor network theory

Collins and Kusch (1998) challenging actor network theory's symmetrical treatment of humans and machines by distinguishing between polimorphic and mimeomorphic actions. Polimorphic actions (throwing a dinner party) rely on social awareness, whereas mimeomorphic actions (unintentionally blinking) do not. Machines, Collins & Kusch argue, are capable only of mimeomorphic actions, whereas humans are capable of both. Thus, while machines may be tools (helping humans do things), proxies (replacing humans), or novelties (doing things, such as flying, that humans could not do without them), lacking intentions, they can only 'behave', where people 'act'. The common belief that machines demonstrate agency is ascribed by Collins & Kusch to human habits of 'repair, attribution and all that' (RAT). Thus when a machine does not behave as expected, humans find ways to work round (repair) the situation, sometimes mistakenly attributing agency to the machine.

For Jones (1999), material agency differs from human agency in lacking intentionality; it is not organized around plans and goals. Machines do not have minds of their own, even if they exhibit agency in the sense of doing things which have consequences for humans. For example the speed of a processor may affect the time required to use an application without assuming that the processor has any intention or volition of its own in doing this. This is not to say that human plans and goals are always explicitly formulated or that human actors are fully aware of their motivations or effective in realizing them; Suchman (Suchman, 1987) makes much of the unthinking actions that people take in response to a given situation in her descriptions of 'situated' action. However, intentions are important in understanding human agency in a way that is not the case for machines. Jones also seeks to find an alternative to actor network theory's assumption of 'strong symmetry,' whilst retaining its 'serious' treatment of technology. Drawing on Pickering (1995), Jones suggests that technological systems need to be understood in terms of the interaction of human and material agency. Thus humans seek to manage (or 'marshal') material agency in technologies, for example to exploit the properties of network hardware to

produce higher transmission rates, while the technologies help simultaneously to shape human practices, such as synchronous long-distance communication, which would not be sustainable without these technologies. For Pickering, technology and humans thereby become 'mangled' together such that it is impossible to separate them clearly. He also argues that the interweaving of machine and human agency is an emergent process. It cannot be decisively known in advance what problems are going to arise in attempts to manage material agency, nor can the ways in which human agency will be shaped by technology be foreseen. Using the metaphor of tuning, as of a car engine or radio, he describes the process of mutual adjustment by which human and material agency are interactively stabilized. Over time, he argues, this process may be seen as a 'dialectic of resistance and accommodation' as humans seek to shape material agency towards particular goals in ways that are not wholly determined either by the intentions of the human actors or by the material properties of technology, but by the interplay of the two. Thus, in encountering problems (resistance) in using a technology, human actors adjust (accommodate), for example by revising goals or practices, or adjusting technological parameters.

Whilst these views of agency are clearly quite different from the specifically human property discussed by Giddens (1984), it would nevertheless seem consistent with his focus on agency as 'doing.' Moreover, as Layder (Layder, 1987) notes, Giddens' focus on human agency and its role in social practice does not necessarily imply that material agency cannot exist, but rather that human agents are able to decide, consciously or unconsciously, how they respond to it. For example, the capability of a computer network to permit data sharing exists whether it is used or not, but humans may decide whether and how to use that capability.

This point is emphasized by Rose & Truex (2000) who focus on the 'perceived autonomy' that humans may attribute to machines. For example people may talk of a recalcitrant cash-dispenser as 'refusing' to issue money. Whether or not they are aware of the history of human design decisions that may have given rise to this 'refusal', their immediate impression would appear to indicate that they see agency as located in the machine. Since, as Thomas & Thomas (1928) put it, 'if men (sic) define situations as real they are real in their consequences,' it is the extent to which humans behave 'as if' machines had autonomy and intentionality that is significant in understanding the interactions of humans and machines, rather than some objectively determined agency (even if this could be established). Moreover, as machines become more complex, their perceived autonomy increases. Complexity also increases the distance between the historical chain of design decisions, all of them originally the outcome of human agency, and the resultant machine, making it easier to consider the machine as an autonomous agent, than to take these decisions into account. This understanding could be related to Giddens' assertion that structure is virtual, and that material phenomena only become resources when drawn upon in social practices. Thus, the mutual transformation of human and machine agency that emerges through their interplay, influences social practice through changes in the perceptions of social actors. This is not to suggest that this influence may not be significant, but that it is mediated by an interpretative process.

To summarize the principle features of this discussion: humans and machines can both be understood to demonstrate agency, in the sense of performing actions that have consequences, but the character of that agency should not be understood as equivalent. Human agents have purposes and forms of awareness and that machines do not. The two kinds of agency are not separate, but intertwined, and their consequences emergent. Those consequences are also the subject of human interpretations which provide part of the context for future actions.

4 The Double Dance of Agency

We identify three features of a socio-theoretical model of the interaction of machine and human agency from our analysis of the 'problem of agency.' From structuration theory we learn that it is meaningless to study agency without studying the situated context in which it is exercised. Following Knights and Murray (Knights and Murray, 1994) we call this context the *conditions* under which agency is exercised. Knights and Murray define 'conditions of possibility' as 'conditions that make certain course of action feasible while ruling out others.' We choose this formulation because it specifically includes technological conditions (such as existing configurations of legacy IT systems), unlike Giddens' structure concept which excludes such material structures. This is also consistent with the majority of the adaptations of structuration theory to the IS field. From actor network theory we learn that a theory of human and machine agency should be able to account for the *process* of the interaction between machines and humans over time. How is it that the two forms of agency combine and influence each other over time to produce particular outcomes? From the comparison of the two theories we learn that human and machine agency is not the same, and we focus attention on this difference by theorizing the different *properties* of human and machine agency.

Properties, process and conditions are related in the double dance of agency model (Figure 1). Each of these will now be considered in more detail.

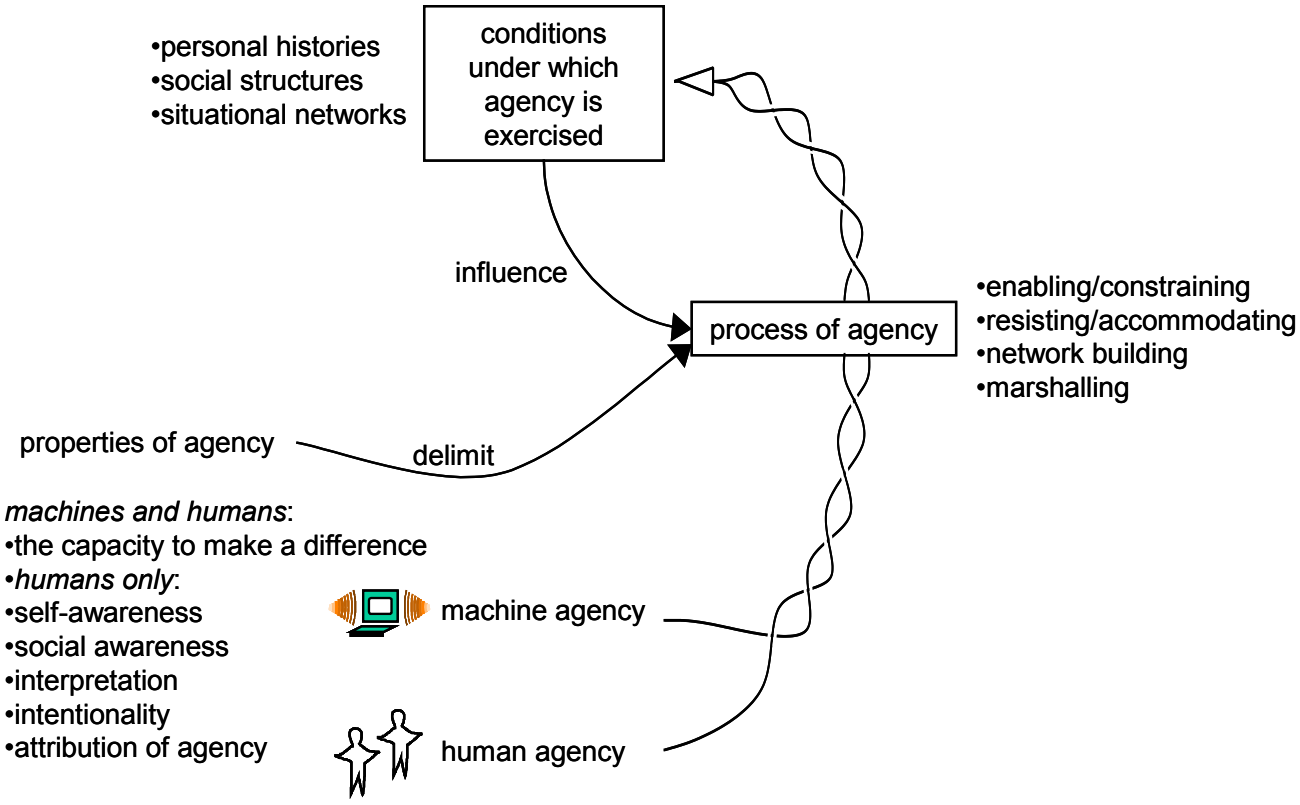

Figure 1. The double dance of agency

4.1 Properties

Agency is defined, following Giddens (1984) as 'the capacity to make a difference,' i.e. to act in a way which produces outcomes. From this perspective, therefore both machines and humans can be said to exercise agency. Indeed, the outcomes produced by machines may often be more evident than that produced by humans – compare the destructive power and of an unarmed human and a nuclear missile. When machines act they can be seen as tools (where they act directly under the control of humans to amplify their capacity to make a difference), as proxies (where they replace humans and act in their stead) or as automata (where they take over some (usually minor) part of human decision making as well as the power to act). Modern organizational computer systems can serve all three functions. However, human agency can be seen to have a number of distinctive properties that differentiate it from machine agency. Thus most humans are normally aware, both of themselves and of their social context. Of course machines can monitor their own internal state and may be capable of identifying, and to a certain extent accounting for, the behavior of other agents, but they do not have the capacity to reflexively evaluate their own or others' purposes and actions in an autonomous fashion. *Self-awareness* relates to an individuals' understanding of their personal history, whereas *social awareness* relates to individuals understanding of their social context (represented as structure by Giddens). Awareness, as Rose and Truex (Rose et al., 2003) point out, is mediated by *interpretation.* Conditions and actions do not present un-ambiguous and universally agreed meanings, but are interpreted through internal personal discourses, and also through social discourse. Machine actions are normally subject to interpretation by humans, whereas a machine does not have the ability to interpret the actions of a human, though it may register them, and provide rule-based or 'learned' responses to them. A consequence of this process of interpretation is that humans also engage in agency *attribution*. That is, they seek to understand phenomena in terms of the outcomes of acts of agency. Thus they attribute agency, causes and outcomes to particular actors, and may act on the basis of those attributions. As Collins & Kusch argue, however, such attribution may often be 'erroneous' in the case of machine agency. More significantly, perhaps, in terms of the analysis of human and machine agency, humans may also act on the consequences of that mistaken attribution.

Another important property of human agency in this context is *intentionality*, or volition – humans can direct their agency towards certain outcomes (though these may not be achieved in the manner intended, or at all). While the autonomy of human intentionality may be debated (many authors argue that human agency is heavily socially conditioned) and it must also be recognized that humans can also act in a routinized (situated) and non-intentional fashion, most current machines can only carry out tasks that at some level have been directed (albeit perhaps unintentionally) by humans. Thus, machines generally do not have the capability to 'decide' what actions to take outside those parameters established by their designers.

While these properties of agency to some extent delimit the scope within which humans and machines may act, they generally do not determine particular actions, especially in the case of humans.

4.2 Process

The study of machine agency (or 'behaviour') also involves the study of the intentions of their human designers and the conditions under which the machines are used, and the study of human agency involves partly the study of human awareness and the way that this helps form the

intention to act. However these 'properties' of human and machine agency do not determine particular outcomes; rather outcomes are an emergent product of a process of interaction of the two types of agency. An IS researcher encounters not separate technical and social components, but an ensemble (Orlikowski & Iacono, 2001) in which the two are inextricably inter-related. It is this mutual interplay over time that the 'double dance of agency' seeks to capture.

A traditional way of understanding the effect of machine agency on human agency is as *enabling* and *constraining*. The fact that a machine is designed in a certain way, and operates in a particular set of conditions, implies that certain human courses of action are made more feasible, and others less feasible (or so overwhelmingly difficult as to seem impossible). 'Technology influences human agency by ……inviting specific courses of action' (Kallinikos, 2002). In this perspective, machine agency is little more than the setting for human agency, part of the 'situation' to which a person responds in acting. Humans may also be active in *network building*: that is in establishing functional co-operations with the machines that they work with in the light of the way that the machines enable and constrain their actions. This may partly involve changing the machines to better suit their purpose where this is possible. Because of the mutually interactive nature of situational machine agency and human network building, it is not necessarily easy to predict the outcomes of such a process.

In the organisational context, the choice of one technology over another may have a relatively strong influence on the actions of individuals, and the trajectory of the organisational group. Humans (for example managers) may explicitly seek to use this aspect of machine agency to reinforce their own intentions (for instance to reinforce a particular organisational strategy); Jones (1998) describes this directive use of machine agency as '*marshalling*' ('to marshal: to arrange in proper order, to cause to assemble, to usher' Oxford English Dictionary). This should not be taken to mean that humans necessarily have control over the outcomes of marshalling; as Pickering (1995) argues, machines may '*accommodate*' some human intentions, but '*resist*' others. This is not to attribute anthropomorphic properties to machines, but to recognize that some human intentions fit more easily than others with the design trajectories of the machines and their influence displayed in organizational implementations. Humans for their part may also resist or accommodate machine agency, recognize these traits in others, and focus them towards their own intentions.

The variability of outcomes in relation to intentions and of resistance and accommodation will tend to make the process of interaction unpredictable. Humans thus rely on improvisation and bricolage to cope with the unexpected. Moreover, initial deviations from the original pattern may become amplified over time leading to significantly variant outcomes from apparently similar initial starting conditions. In emphasizing the emergent and unpredictable character of the process of interaction of machine and human agency, however, there is a danger of overlooking the stabilities. As Actor Network Theory describes, humans and machines can become enrolled in relatively stable networks (configurations of practice), some of which may even become sufficiently stabilized to be 'black boxed', such that the opportunities for agency in transforming them are no longer perceived to be necessary. For example, an established routine for carrying out a task may not change, despite the introduction of an information system that provides the opportunity for its radical redesign. As this illustrates, human capabilities of attribution and perception are important features shaping the way in which the process of interaction between human and machine agency works out.

The double dance of agency may be seen both in the machine's design and development, as developers struggle to configure material artifacts (usually with the help of other machines) to achieve their objectives, and also as users struggle to appropriate the artifacts produced by this process to their particular needs (which may be a poor match for those intended by the designer). As Akrich (1997) argues, while designers may seek to 'inscribe' in the technical contents of the artifact they create their vision of (or prediction about) the world into which it is to be inserted, it is in users' encounters with the artifact that these visions are 'de-scripted' and are realized (or not).

In as much as human and machine agency is mangled and conflated, it becomes an emergent process in which outcomes are seldom entirely the result of one form of agency, and seldom easily predictable. Each set of emergent outcomes, become the conditions under which the next actions are taken.

4.3 Conditions

The process of interaction between human and machine agency does not operate within a vacuum. Rather, it takes place within conditions ('conditions of possibility' (Knights and Murray, 1994)) that pre-exist the particular instance of interaction and may influence it. Individuals thus encounter their own and machines' agency in the context of a personal identity that has a history and may also be seen as pursuing a particular trajectory into the future (Giddens, 1992). That *personal history* (here we refer primarily to previous experience of the interaction of machine and human agency) may be a major factor in the interpretation of acts and conditions and be an important component of individuals' self-awareness via personal reflexivity. As has already been noted, however, humans are not only self-aware, they are also socially aware. Social awareness makes possible the existence of broader *social structures* that are both the medium and outcome of human action (Giddens, 1984). Social structures (which also relate to technological artefacts: cf Orlikowski's technological structures) influence which human acts of agency are considered legitimate and how machine and human agency is later interpreted. Communicated understandings of acts of agency (whether machine or human) feed back into social structures and have the power to reproduce or to transform them

The situated character (Suchman, 1987) of the process of interaction of human and machine agency has two important implications for the model. It suggests that the outcomes of the operation of agency need to be considered in terms of the particular circumstances of their interaction. These circumstances may be both social (a generally perceived problem with legacy systems) and material (the physical inability of legacy systems to communicate with each other). We use the term *situational network* to describe the particular socio-technical circumstances in which human and machine agency take place. As Pickering (1995), points out, however, it also has a further, subtler, implication for the role of human intentionality in the 'double dance of agency'. Thus, while human goals may orient action they do not control it, and may themselves be transformed in practice through their encounters with machine agency. As Suchman (1987, ix) argues 'plans are best viewed as a weak resource for what is primarily *ad hoc* activity'.

Personal histories, social structures and situational networks are emergent: that is, though they influence the process of agency, they are also in part the outcome of it.

4.4 The double dance

The model of human and machine agency developed here proposes, therefore, that human and machine agency have different properties, but that the outcomes of their operation are emergent from the process of their interaction (rather than being determined by either); and that these interactions take place under conditions that shape outcomes, but may also be transformed by them. The separation of the three features is therefore largely an analytical convenience, since they are mutually interrelated (for example, properties influence process, process shapes expression of properties, conditions affect process and so on).

5 Discussion

This interplay of agency and conditions in the 'double dance of agency', whereby the interaction of human and machine agency is shaped by, but also shapes the context of interaction, may be related to the agency/structure duality described by Giddens (1984). Moreover, Giddens' notions of unacknowledged conditions and unexpected consequences may be helpful in understanding the emergent outcomes of this interaction. The 'double dance of agency' model, however, in contrast to structuration theory, explicitly incorporates machine agency in the emergence cycle. Human agency, it is suggested, is not absolute, but responds to and itself shapes machine agency. In further contrast to structurational theory, the presence of previously existing technological artefacts (computing infrastructure, legacy systems) is acknowledged in the concept of situational network, and assumed to be influential upon agency. This would seem to be essential to the development of IS theory, unless Giddens' claim that 'technology does nothing, except as implicated in the actions of human beings' is taken to refer only to the effects of technology on social practice. Even here, however, it would seem helpful that understanding of these effects should be informed by an awareness of the material capabilities of the technology, rather than relying solely on the perceptions of the social actors. This is not to claim that accounts that correspond most closely to material capabilities are necessarily correct, but that accounts that acknowledge these capabilities may provide more fruitful understandings of IS phenomena, including the possibility of mistaken attributions of material agency.

In its view of the organisational effects of information technology as the product not solely of human agency, but of its interaction with machine agency, the 'double dance of agency' model may be seen to be closer to actor network theory. In contrast to actor network theory, however, the 'double dance of agency' specifically differentiates properties of human and machine agency and identifies a context, including institutional features, such as industry trends, that shape practices. While it may be argued that context is addressed within actor network theory in terms of peripheral influences in long networks (c.f. Latour, 1998), the flat ontology of actor network theory does not lend itself easily to considering the effects of large-scale social organisation (Reed, 1997). Thus the 'structuring' effects of networks over space and time, particularly in terms of the shared understandings of the human actors, but also in terms of the influence of shared technologies, is underplayed. Thus, although analytical scepticism with respect to the role of human and machine agency may be appropriate, treating them as equivalent and focusing only on the immediate networks of influence as actor network theory does, would seem more useful in the retrospective reconstruction of events, than as a means of understanding the emergence of practice through 'people's repeated and situated interaction with particular technologies' (Orlikowski, 2000: 407).

The Double Dance of Agency model focuses attention simultaneously on the interlinked agency of humans and machines and the socio-material conditions which are both context and outcome

of that agency. At the same time it differentiates between the agency of humans and machines, acknowledging that both forms of agency have consequences, though they are not equivalent. An analysis of an organizational implementation of an ERP system (as an example), using this theoretical framework, could account for many complex phenomena. It could account for the influence of both the legacy systems (there ability to interface and produce summary data) and the decision maker's perception of how wide reaching a problem that was. It could account for both the influence of the decision makers and the influence of the ERP system itself on the trajectory of the organization. It could help to show the emergent process of the implementation, as organization members struggle to adapt the new system to their individual purposes, and use the opportunities it presents to further their own interests. It could also help to understand new sets of organizational situations and possibilities brought about the combined influence of the computer system and its human stakeholders.

5.1 Conclusions

The interaction of technology and organisations has been a long-standing and fundamental issue in the IS field. In this article we have focused on two of the theoretical sources that IS researchers have adapted to try to demonstrate a middle way between the extremes of social and technical determinism. Concerns about the peripheral treatment of technology in structuration theory have lead to an interest in actor network theory in which technological, or more generally non-human, agency is assigned a significant position. In comparing the two theories we focus upon agency/action as their apparent common staring point, but find that the treatment of agency is non-convergent, making it difficult to combine the theories effectively. This we characterise as the 'problem of agency.' Of course it is possibly to use both theories separately, as sensitizing devices, or in theory adaptations which try to include theorisation of issues fundamental to IS research. However, our analysis of these adaptations shows that IS researchers had difficulties in incorporating technology in the structuration theory framework because of its anti-realist ontology. They also, in practice, had reservations about actor network theory's symmetrical treatment of human and machine agency. Much of this critique can be found in direct commentary on the two theories, but also in more recent contributions focused on aspects of human and machine agency and their interaction.

In seeking to construct a socio theoretical account of the interaction of human and machine agency relevant to important research issues in IS (the double dance of agency), we drew on one central insight from structuration theory, one central insight from actor network theory, and one insight derived from their comparison. Structuration theory teaches us that agency is both creator and product of its context. Unlike Giddens, however, we choose to understand that context as both social and material. This allows us to directly theorize the impact of technologies upon agency and vice versa. Actor network theory encourages us to take the actions of machines seriously, and to understand how the agency of human and machines is mutually dependent and intertwined. However the comparison of structuration theory and actor network theory demonstrates that human and machine agency cannot really be thought of as equivalent. We differ from actor network theorist in sharply delineating the agency of humans and machines, and in emphasising the structural role of socio-technical networks as part of the context for action. The metaphor of the 'double dance' attempts to encapsulate both the intertwined nature of the interaction of human and machine agency, and its part structured, part improvised emergent character.

One obvious application of the double dance model is in the study of the implementation of large organisational systems. Important to this research endeavour, but not reported here in order to devote space to the theoretical arguments, has been the empirical study of the implementation of ERP systems. ERP systems are widely understood to have significant organisation impacts, and their implementations provide good opportunities for the study of the phenomena characterized by the double dance of agency. A practical application may be in the management of such implementations. Many large implementation projects are still run according to conventional project management models, which disregard machine agency (here the on-going effects that the IT system has on the organization). Management of such projects based on the expectation of emerging patterns of outcomes made unpredictable by the agency of the machines might be very different. In purely theoretical terms, we would hope that the model contributed to, and encouraged the development of independent socio-theoretical accounts of IS which are less slavishly bound to their reference theory (ANT, ST, etc.), and more focused on immediate IS concerns.

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