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SITUATED ACTION, STRUCTURATION AND ACTOR-NETWORK THEORY: AN INTEGRATIVE THEORETICAL PERSPECTIVE

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ABSTRACT

Recently, IS researchers have borrowed theories from other academic fields in the hope of enriching their theorising about the use, adoption and diffusion of material systems by human actors. Situated Action, Structuration theory and Actor-Network Theory (ANT) are cases in point. Arguably, rather than borrowing theories ready-made from alien disciplines, we should investigate their meta-theoretical commitments and apply these directly to IS problems. This paper argues that the notion of viewing intentional action from the "ground view" of a situated agent is the essential theoretical move underlying these theories. The notion of situated action is developed systemically as an alternative to the widespread deliberative view of action, and it is shown that the key notions of Structuration and ANT arise out of this exposition in a rather natural way. By demystifying these theories in this way, it is hoped that in future IS researchers might draw directly on the more fundamental notion of situated action in theorising the role of IT/IS in human intentional action.

1. INTRODUCTION

Having recognised that the objective properties of production systems, IT, IS and operational reforms are insufficient to account for the difficulties of having them put to human use, management and systems theorists realised the need for a socio-technical account of these problems, at least by the early 1970s (Trist 1982). The early socio-technical systems theory notion of joint optimisation of the social and technical proved too static for the task. More recently, IS theorists have sought to borrow from the social sciences more dynamical theories of human intentional action and its relation to social structures and physical artefacts.

Three cases in point are: the idea of situated action (Suchman 1987; Hendriks-Jansen 1996; Clancey 1997), which has been influential particularly for human/machine interaction studies (Greenbaum and Kyng 1991), Gidden's Structuration theory (Giddens 1984) which has been influential in IS adoption studies (Orlikowski and Robey 1991; Walsham 1992; Shanks 1997), and most recently Actor-Network Theory (ANT) (Callon 1986; Latour 1987; Law 1992) which has been used to account for the entrenchment of infrastructure standards and systems ideologies (Walsham 1997; Monteiro 2000). Application of these theories has not been without difficulty. Because Structuration is a theory essentially about social action, incorporation of material systems is not entirely natural (Orlikowski and Robey 1991). With ANT the notion that physical

objects should be spoken of as actors on essentially the same footing as humans has been difficult for some to swallow (Collins and Yearley 1992; Pels 1995).

The purpose of this paper is to show the essential connection of Structuration and ANT to what is arguably the more fundamental issue of the situated view of intentional human action. The reason to do this is to show that the tenets of these theories become more reasonable and natural as ways of describing the world of action when they are formulated within the situated action viewpoint. Thus, a detailed and precise explication of the theoretical commitments and position of the situated action viewpoint, which is not readily available to an IS audience, should allow these theories to be applied more precisely and innovatively in IS research. In particular, the view is advocated here that we should not be borrowing theories fully-made from other disciplines but rather taking the essential features of these theories which are useful to IS studies, and this is best done when the overarching or meta-theoretical aspects of these theories are fully understood.

2. THEORIES OF INTENTIONAL ACTION

The starting point is the idea of *intentional action*. We routinely view our own actions as intentional, that is, directed to the achievement of goals. This is because our sense of free will suggests to us that we have sufficient autonomy from the constraints of the physical world to allow us to consciously decide the future by aiming actions at future goals. This is a notion of *intrinsic* intentionality and can only be appropriately applied to conscious organisms. However, according to Dennett (1996), the behaviour of any system, human or non-human, that is sufficiently complex to warrant it can be viewed as intentional in a somewhat different sense. The idea that such systems are pursuing goals is an *ascription* of an observer used to give a parsimonious description and explanation of their behavior. Although this paper deals mainly with human intentional action, it is worth remembering that the theories set forth here can also be used to describe intentional action of robots, software agents, swarms of insects, organisations and industries, provided that this *ascriptive* type of intentionality is employed.

Once we decide to describe action in terms of goal-seeking behaviour, which is a particularly natural thing to do, for example, when studying the human use of material systems, the question arises as to the nature of intentional action or agency. Recently, a number of authors (Brooks 1986; Agre and Chapman 1987; Suchman 1987; Hendriks-Jansen 1996; Johnston and Brennan 1996; Agre 1997; Clancey 1997) from diverse disciplines have argued that there are essentially two main views on the nature of intentional action, which will be referred to here as the "deliberative action" theory and the "situated action" theory. It is worth considering each of these in detail before proceeding to Structuration and ANT, firstly, because most of us are too close to the deliberative action theory (it being pretty much the default western view of intentionality) to see its weaknesses, and secondly, because the situated action theory is foreign to many and there is no unitary exposition of it in the literature. (This paper follows most closely that of Agre (1988; 1997))

The most widely held view of intentional action, yet arguably the least tenable, is the "deliberative action" theory. This theory posits that the agent possesses a symbolic model of its world acquired by learning. This model takes the form of a set of symbols and attributes that represent the objects that make up the world and their properties, and a system of relations between symbols that represents the relations between objects in the world. Particular states of the world and the agent correspond to particular instantiations of the world model. Intentions are represented as desired states of the world and the agent's relationship to it. On this view, intentional action proceeds as follows. The agent uses sense data to determine the current state of the world and its position (metaphorically) in it. It then uses deductive processes to produce a set of formal actions (a plan) that will transform this current state into the intended or goal state. The plan is executed until the goal state is reached or the planning cycle needs to be repeated. Thus, the deliberative agent acts in the physical world by building an abstract model of the world and using that model to determine what to do in the physical world (see Figure 1).

This seems to be our folk theory of action. It was very literally translated in early attempts to build autonomous mobile robots (Raphael 1976), as well as being the basis of the Physical Symbol System Hypothesis of Newell and Simon (Newell and Simon 1981) on the nature of intelligence and much of the

cognitive sciences (Gardner 1985). It is also continually put forward as a basis of planned organisational action (Johnston and Brennan 1996).

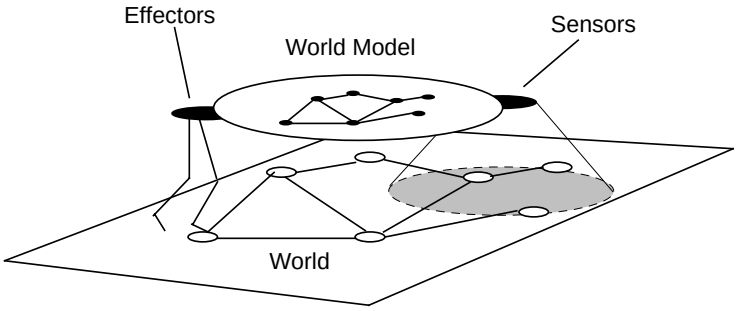

Figure 1: *The Agent and its Relation to the World as Envisioned in the Deliberative Action Model*

Although this deliberative mechanism of action undoubtedly plays some role in intentional activity, it is extremely difficult to deploy as a principle of on-going, and especially routine, activity. The problem is that it necessitates that the agent engage in a continual translation from sense data to abstract model and back again to action (see Figure 2). The abstract model that forms the basis of action is essentially a view of the world, and the agent's position in it, from "outside" - from some "aerial" viewpoint away from the action (Agre 1995). It is an objective view of the world removed from the intentions of any agent. However, the agent must simulate this view using the highly skewed data available to it from its situated "ground" view, and limited by its physical embodiment. For instance, and agent relying on vision cannot see around corners, probably cannot see what is behind it, and views details of the world with different significance depending on its scale (the cracks under doors are navigationally significant to ants but not humans). This requires a complex, lossy and essentially infeasible translation process. Then, when it deduces a set of abstract actions (formal transformations of world state) it must translate these back into actions of an agent with embodied limitations and a world of infinitely greater complexity than its model. And all this needs to be done in real time since we generally need to act *now* – we are always "thrown" into the action. The difficultly of this process of translation from the agent's situated, embodied and thrown ground view to the disembodied, objective, transcendental aerial view means that episodes of deliberative action should be viewed as rare and difficult feats, not the basis for routine on-going activity.

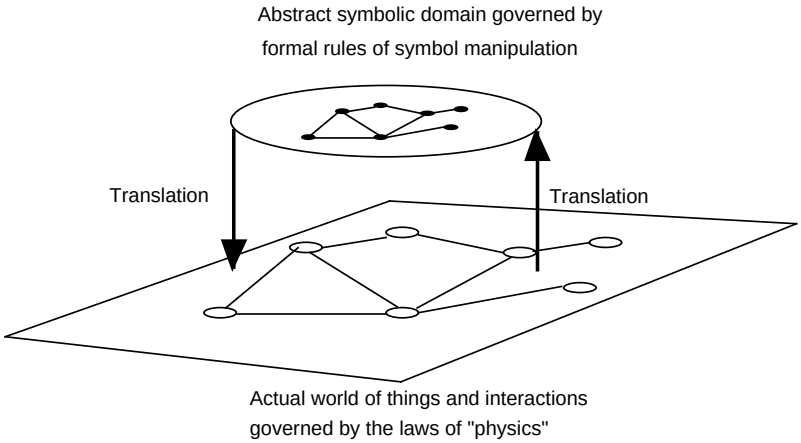

Figure 2*: The Deliberative Action Model Demands a Continual Translation between the World Model and the Actual World of Action*

These considerations have led researchers in many fields dealing with the design and explanation of intentional action, to adopt an alternative view of on-going intentional activity often referred to as "situated

action" (Brooks 1986; Agre and Chapman 1987; Suchman 1987; Lave and Wegner 1991; Hutchins 1995; Hendriks-Jansen 1996; Agre 1997; Clancey 1997). The situated action theory makes two essential breaks from the deliberative view. Firstly, it insists that the agent should generally make use only of sense data acquired directly from its situated, embodied ground view with little processing. For this purpose it posits that the agent responds to situations using a limited repertoire of largely reactive response actions. Situations play the role that world states did in the deliberative action theory but they are essentially different: situations are agent-centred views of the world from its situated, intention-laden point of view. A situation might include "the threatening nature of a street corner" for instance, a concept with implications for action that can hardly be captured in an objective world model. Secondly, the theory gives a far more active role to the environment of the agent in achieving intentions. Just as the agent responds to aspects of its environment with certain routine actions, so the situation changes in response to the agent's actions. This is because situations are agent-centred views of the world so each action alters the agent's situation. However, how a situation is altered by an action of the agent is far from arbitrary: it is determined by the *structure* present in the environment of action. So the sequence, action - environmental response – action – environmental response, which determines outcomes, can be viewed as being as much due to the structure of the environment as the set of response rules applied by the agent. If the goal situation is amongst this chain, then goal attainment is just as much due to structure of the environment as actions of the agent. This strong role for environmental structure in the situated action theory is not apparent in the deliberative model because any structure in the environment is subsumed within the abstract world model and hidden in the deductive process.

The idea of environmental structure and its role in situated intentional action is so important as to deserve elaboration. Imagine a boy playing a computer adventure game, the type that involves navigating rooms, selecting significant objects, and so forth. He responds to certain features of his simulated situation in the game, as displayed on the screen, with actions (mouse clicks). The game program responds by presenting a new view on the screen, a view from his simulated viewpoint of the resulting game situation. A simple model of the boy's behaviour would be a finite state machine that issues mouse clicks as a response to features on the screen as it changes state. But this is also a perfectly valid description of the behaviour of the game program: it issues screen views as a response to inputs from the mouse as it changes state. The progress of the boy/game interaction is determined as much by the boy's responses as by the programmed responses of the game. The program's response repertoire is predetermined by the structure of the program, which embodies the "physics" of the simulated world. The boy's repertoire evolves in relation to the unfolding scenario and can be "tweaked" over time until the goal is attained. In the adventure game case it may be possible for the player to gradually construct a model of the simulated world and deduce a sequence of moves that solves the game in a way envisioned by the deliberative action model. However, it is more likely that any such deductive processes are used to readjust situated responses rather than as the underlying *principle* of action. The more dynamic the game and unpredictable the simulated world, the more likely this is to be true (Agre and Chapman 1987).

This is a natural description of video game playing because the screen displays a situated point of view on the action. We do not often apply this view to our own on-going action: our Cartesian legacy seems to require us to view action from outside ourselves. Viewing the world and action from the actor's point of view was the essential theoretical move of the phenomenological philosophers, particularly Hiedegger (Dreyfus 1991), whose influence is present in situated action theory. From this agent-centred view our everyday activity is a dance (see Figure 3) between ourselves as relatively autonomous agents and an environment of rich structure that takes for us much of the cognitive burden of on-going activity and thus has a substantial claim to "agency" (Chapman 1991). We can think of the environment as a *co-agent* involved in intentional action just as the game program is in the above example. Intentional action is a process of monitoring the effectiveness of simple, myopic, largely routine responses to situations for eventual goal achievement and tweaking these responses if goals are not forthcoming. Only on rare occasions and with great difficulty, perhaps as a response to total breakdown of the effectiveness of routine actions, do we resort to the difficult task of building an aerial view of our situation in the world and derive our immediate actions from it. We use such episodes mainly to readjust typical situational responses. This idea of an agent-centred

or ground view can be applied also to non-human actors: in that case it means centering the descriptive frame of reference on the agent and discussing the way the agent responds to data it acquires about the world only in terms of what is directly available from its sensing systems (Brooks 1986).

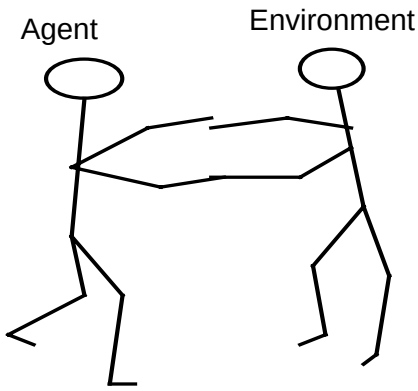

Figure 3: *The Agent and its Environment as Envisioned in the Situated Action Theory. After (Chapman 1991)*

Of course we want to consider actions in worlds that present more than mere navigational tasks to agents. The environments of such actions include the physical world with physical constraints but also may include the actions of other agents introducing the possibility of communicative, political, cultural and economic dimensions to environment structure that are much less easily visualised. However we can take from the easy-to-visualise navigational example above the most important aspect of the notion of "environmental structure". For navigation tasks, it is tempting to think of structure in terms of relationships between the "furniture" of the world viewed from the aerial view. Alternatively, we can think of environmental structure as it is appreciated from the ground view of a situated agent. In this case, structure is seen as a set of regularities in the situations that occur in response to the agent's actions. This is how structure of the simulated game world presents itself to the video game player. This later view of structure is most easily generalised to include social and organisation dimensions of structure. This notion of environment structure has been formalised by Horswill (Horswill 1995; Agre and Horswill 1997).

3. SOCIAL SITUATED ACTION: STRUCTURATION

Now consider the environment of an agent that consists, not only of the physical world, but also of the actions of other agents. This last component adds a new source of environmental structure as defined above. The possibilities and consequences of action as expressed by the situations that result from action are constrained in new ways as a result a set of power, normative and communicative relations (among others) in which the actors including the focal agent are engaged, and these constraints are evidence of social aspects of environmental structure as defined above. This social structure is not easily represented from the aerial perspective as configurations of material in space. However, it is still detectable in the way it reduces the possible range of situations that present to the agent and the possible situations that will arise in response to a certain actions of the focal agent. Power and normative structures are largely sensed through the consequences of actions. Similarly, communicative structures work through their ability to reduce the arbitrariness of communicative acts and responses to communicative acts. According to the situated action view which has been outlined above then, the outcomes of (social) action will be as much a consequence of the focal agent's action responses to situations, as of the (social) structures that are present in the social environment of action, but strictly determined by neither individually. Thus both social structure and human action have causal status for social behaviour but not in a strict deterministic sense. A sentient actor can always choose to break a rule, but to do so repeatedly would undermine the ability of the environmental structure to assume part of the cognitive burden of action, so these causal forces tend to ensure a certain

outcomes in a statistical rather than determinate sense. This is essentially Giddens' resolution to the structure/action debate in sociology.

But there is an essential new consideration in evaluating the constraining and enabling nature of social structure, which is that it is not *given* in the way that physical structure was in our previous discussion: social structure arises as a result of the typical actions of agents, one of whom is our focal agent, whose actions are partly determined by that structure. This involves the agent in both aspects of situated action in a peculiar way. The agent employs a certain repertoire of actions to deal with situations, but the situations with which it subsequently has to deal, by virtue of the structure of the social environment, are partly also determined by its repertoire of actions. The result is that those social structures that persist for any length of time, and those typical repertoires of situated actions (which are social practices or routines) that persist for any length of time, must bear a certain relationship to each other: the structures must be those that tend to enable the routine actions and the routine actions must be those that tend to reproduce the structures. They are, in the language of dynamic systems theory, "attractors" or "fixed-points" of the interaction between structure and situated action (Beer 1995). This process of reciprocal reproduction of structure and action is what Giddens calls "structuration" (Giddens 1984, p191) or elsewhere, the duality of structure (Giddens 1984, p25).

Thus we have arrived at the essence of Giddens' theory more or less as a direct consequence of viewing social action according to the situated action approach to intentional action. The duality of structure and action thus derived can be traced directly back to the duality, or co-agency, of environmental structure and situated action already present in the situated action theory. This together with the unique aspect of social action, namely that each agent's actions are implicated in the creation of social structure, produces the result. It is this reciprocal involvement of individual discrete actions in formation of social structures that enable future actions, which provides the causal mechanism by which long-term social practices persist. We can equate Giddens' notion of structure with the social component of the above notion of environmental structure. Like Giddens' notion of structure it does not determine action in the way envisioned by structuralists. Also, like Giddens we see social structure as an abstract property of an agent's social world manifesting itself through the consequences of action. However, the present definition is more precise and general than Giddens' 'rules and resources' which 'exist only as memory traces' and are 'instanciated in action' (Giddens 1984, p377) which has come in for some criticism (Thompson 1989). Expressed in terms of the way in which situations are presented to agents in response to their actions, the notion of structure used here can be applied to non-human agents and can include social and material aspects of structure. We can equate situated actions with Giddens' notion of agency, neither completely arbitrary nor completely determined. Connecting environmental structure and agents' situated actions are their repertoires of action, which can be equated to Giddens' "modalities". They are collections of rules and strategies that make intentional situated action possible within the arbitrariness of action and the constraints of structure. They are also the conduits through which structures and routine actions are reproduced.

In addition, the approach presented here makes it clear that groups of humans, or indeed groups of other types of agents (such as firms), can be thought of as engaged in collective intentional action without the need to postulate that they share a collective representation of their joint actions. This is because they share instead a common environment which is partly causative of action. This observation goes some way toward answering the question of whether loose collectives such as organisations or industries can be spoken of validly as pursuing goals (Johnston and Gregor 2000).

4. BEYOND STRUCTURATION

Giddens' structuration theory deals exclusively with social aspects of human action and was created to offer a solution to a particular problem in sociology. As such, there is hardly any sense in the theory that social action happens in the physical world. This aspect of the theory has presented a challenge to researchers wishing to apply it to technology issues such as the implementation and adoption of IT/IS. The problem stems from the exclusive focus of the theory on social structure and its relation to action. The most attractive place to put technology in the theory is as the material environment where modalities are enacted (Orlikowski and Robey 1991; Shanks 1997), that is, as the medium of the structuration process.

Viewing structuration as an aspect of the larger issue of situated intentional action of agents in structured environments suggest other possible ways of connecting the material and social/organisational aspects of human action. For instance, on this view action is constrained and enabled by both by the presence of social structure and material structure in the action environment. Material and information systems might be viewed not just as a vehicle for social structuration, but as an aspect of structure itself. Furthermore, physical structures might be considered to be reproduced by there own reciprocal relation to habitual practices, namely that their presence may strongly simplify the use of routine practices and therefore tend to be reproduced simultaneously with them. In fact, the reciprocity of structure and intentional action is present in a number of writings other that Giddens', which are sometimes collectively referred to "second-order cybernetics" (Maruyama 1963; Varela 1984; von Foerster 1984; Varela et al. 1991; Maturana and Varela 1992; Agre and Horswill 1997). Finally, material structures and social structures might be co-reproduced in ways that are difficult to untangle. Bourdieu (1990) has pursued this notion extensively at anthropological time scales. Each of these possibilities has implication for how human use of IT and IS could be theorised in social settings, which are beyond the scope of this paper. However, it is worth pursuing for a moment the issue of reproduction of physical structure and its relationship to situated action since it will enable us to make contact with Actor-Network Theory, which has also gained some popularity recently in IS as a way of dealing with the social use of material systems (Walsham 1997; Monteiro 2000).

5. THE AFFORDANCES OF MATERIAL STRUCTURES

Certain kinds of structure in environments are particularly useful to situated agents. These are structures that constrain the agent's space of possible actions in such a way that very simple strategies can be used by the agent - strategies that require little remembering of past actions, and use a simple "hill-climbing" or "greedy" approach to closing on the goal. An example is the property of a class of mazes that allows them to be traversed with the simple rule "keep your left hand on the left wall at all times". This is the structural property of being "singly-connected" (having no closed circuits) and is true of many real mazes. Less restrictive, but similar in principle, is the partitioning of space to limit possibilities of human actions. As you enter a house the mere existence of, and the connectivity of, the rooms dividing up the space constrains enormously the possible next situation you will encounter. When you are in a kitchen and you need a knife, the very existence of kitchens, dressers, cutlery draws, and knife compartments, means that you do not have to engage in an exhaustive search of the entire house to find a knife. It is just this type of exhaustive search of possibilities that the deliberative action model takes as the basis of all intentional activity.

Then there are objects that have particularly strong constraining and enabling properties for certain types of actions. The most extreme category of these is "jigs" which constrain the possibility of action (for example, where to drill holes in a work piece) almost completely, removing the need for planning and deciding. A more multi-purpose version is "tools". Agre and Horswill (Agre and Horswill 1992; Horswill 1995; Agre and Horswill 1997) have shown using computer simulation how the properties of tools used in a task like cooking breakfast limit the possibilities for action so strongly that cognitively demanding processes such as planning and back-tracking become unnecessary. In a sense tools compile plans and make them available when required. The activity and the tool may have, in many cases, been invented simultaneously, and at the same time given rise to previously un-thought-of intentions. Once the utility of a tool is realised, the knowledge of its use, and the potential intention to use it, are passed on simply by passing on the tool. Agre and Horswill (1997) have argued that cultural artefacts such as house designs, tools and systems, such as double entry book keeping, are reproduced and perpetuated with the situated practices that they enable because of their ability to strongly constrain the cognitive burden of those practices. They dub this phenomenon "cognitive autopoiesis".

6. THINGS AS AGENTS: ACTOR-NETWORK THEORY

We have reached a point in the argument where it begins to make sense to view inanimate objects and material systems as agents or actors, or at least co-agents of human intentional action. We saw that when we

viewed action from the ground view we were led to recognise the structure of the environment of action as an essential contributor to intentional action, and therefore intentional action is best conceptualised as an interaction between a focal agent with distinctly bounded deliberative powers, and an environment that possesses a degree of agency as well, by virtue of the affordances of its structure for action. It is only a small step from this viewpoint to describing the interaction of humans with their inanimate environment in terms of an interaction between human and non-human agents on a largely equal footing, which is the essential theoretical move of ANT.

This move does not make sense from the aerial viewpoint of the deliberative theory of intentional action. This is because the aerial view is supposed to be objective in the sense that it is freed from any particular agent's, situated, embodied, intention-laden viewpoint. From the aerial view all things in the world are intention-free. Intentions are put back into this objective world only at the point when a particular agent deploys the deliberation process to link its intentions to actions. Therefore, the idea that objects that are not specifically marked in the theory as being capable of deliberation should be viewed as agents, is particularly alien. Since the deliberative action view is pretty much our default view of intentionality its not surprising that the idea of attributing agency to objects, even for mere descriptive purposes, should meet strong resistance (Collins and Yearley 1992; Pels 1995). The deliberative action standpoint, which assumes thinking is the basis of, and pre-requisite for, intentional action makes the idea of attributing agency to anything that cannot think heretical. On the other hand, when one abandons this strong rational and objective approach to intentional action, which as argued above is necessitated by the infeasibility of any agent using a constant translation to the aerial view, one recognises that the affordances of the structure of physical and social environments of action become as important as deliberation or thinking to explaining the possibility of action, and this move becomes much more natural.

We can see in the above account of tools and other aspects of the physical environment as co-agents that enable certain human action possibilities, many of the important ANT notions (parenthesised below). By a process of co-evolution, or cognitive autopoiesis, certain features of physical objects (such as the weight of a room key in Latour's famous example (Latour 1991)) become reinforced ("enrolled" and "translated") because of the possibilities they afford for intentional human action. Subroutines for action become compiled ("inscribed") in these object configurations when they prove to be useful in multiple episodes of intentional activity. At a certain point in this process some physical configurations may be recognised as so useful that they fall out of the process of mutual reproduction (are "black-boxed") and are reproduced in their own right as objects with multi-purposes. Tools, house designs, the ASCII keyboard and double entry bookkeeping are examples. Because of the potential of these things to reduce dramatically the cognitive burden of action through their use, they develop through their reproduction a strong resistance to change ("immutability"). We have arrived at these correspondences of the situated action view to ANT without the anthropomorphic terminology that puts many off ANT.

But is this move necessary? Is it not possible to describe the role of physical things in intentional action equally from the deliberative action theory's aerial viewpoint without ascribing agency to them. After all, all aspects of the environment including what we have called its "structure" are surely present in the deliberative agent's world model. These are wrong-headed questions. The point about adopting a radically different point of view, as with the change from the Ptolemaic to the Copernican in astronomy, is that while there might be a formal equivalence between the view points, they nevertheless differ on what phenomena are seen as central and which as peripheral (Agre 1997, p38). It may be possible to detect from the aerial view, some recurring role in action of a certain configuration of material (say a hammer) over a number of different episodes of deliberative action when optimal action sequences are deduced in the way advocated by the deliberative action model. But it would be very difficult to give an account in this way of the versatility and autonomy of a hammer viewed as an all-purpose tool, which is so obvious to us when it is viewed as an artefact laden with potential human uses rather than as a material configuration of atoms. The deliberative action view puts the agent's reasoning powers to the fore, relegating things in the environment to a passive backdrop of action. The situated action view brings the designed affordances of things for human action to the fore precisely because of the infeasibility of describing the richness of human experience deductively from an objective specification of the furniture of the world.

7. CONCLUSION

This paper has argued that the notion of situated action provides an integrating perspective for understanding the theories of Structuration and Actor-Networks that have recently been imported into the IS theorist's arsenal. It has been argued here that it is the move of viewing and explaining action from the ground view of a situated, embodied and thrown agent, which is accompanied by the need to ascribe a greater significance (even agency) to environmental structure, which is the fundamental theoretical move that makes sense of these theories. When this approach is used to describe the social conditions of individual action, the Structuration theory notion of the duality of social structure and action arises in a natural way. In addition, the move of viewing action from the situated ground view of the focal agent renders the descriptive stance of attributing some form of agency to material artefacts and systems, as advocated in ANT, more plausible than it is within the dominant deliberative approach to intentionality with its aerial perspective on action. The more active role that environmental structure plays in situated action along with the ability of certain structures to assume much of the cognitive burden of agent action provides a convenient way of understanding how some material artefacts, including information systems, can acquire a form of co-agency in human purposes which is not readily described when the artefacts are viewed as part of the passive backdrop for deliberative action.

The perspective presented has the potential to provide new ways of theorising socio-technical systems involving IS/IT beyond simply massaging for the task, theories that were built for other purposes in neighbouring disciplines. Compared to Structuration theory for instance, in this perspective social structure is seen as just one aspect of environmental structure in general, which may include the structuring affects of material systems such as work environments or information systems. As a result, possible relationships between information systems and work practices other than those so far formulated within the Structuration framework can be contemplated. For instance, when describing a socio-technical system, what constitutes the focal agent is largely arbitrary (as with any system / environment split) and chosen by the theoretician for convenience in investigating particular research questions. The focal agent may be viewed as the user-plus-information-system with the environment largely social. Alternatively, the focal agent could be a system user alone, with the information system viewed as part of the environment. This would not necessarily reduce to technological determinism because, from the perspective of this paper, mutual structuring of agent actions and environmental structure would still be possible through the mechanisms discussed in section 4 and 5. The manager may be chosen as the focal agent with users part of the environment. Many other agent / environment splits are possible. The established approach to using Structuration theory to describe socio-technical systems appears to be to place technology at the boundary between actors and social environment. (Recently, Orlikowski (2000) has presented an alternative approach). The perspective advocated here of viewing on-going intentional action as an interaction between the repertoire of responses of the focal and structure of the environment can be worked through for any of these agent / environment splits. One would define what constitutes the situations of interests, agents responses to situations, and environmental structure, defined above as probable new situations which result from agents actions. One would try to work out for existing practices how the environmental structures tend to reproduce the agent action repertoires and how the latter tend to reproduce the environmental structures. This would form a basis for investigating the effect of changing existing technology or adding new technology upon the process of reproduction of practices and, to the extent that they are predictable, the likely outcomes of such changes. Although this proposal for a "situational / interactional analysis of sociotechnical systems" has not yet been worked into a full-blown research methodology, progress toward this end can be found in (Johnston 1999), in the context of manufacturing operations systems, and in (Johnston and Gregor 2000) and (Gregor and Johnston 2001) for interorganisational systems.

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