Actor-Network Theory and Information Systems Research

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Abstract

In this paper, the authors will advocate the addition of actor-network theory to the qualitative research traditions presently used in information systems. We will contend that actor-network theory can be especially useful when studying the implementation of information systems and in other situations involving technological innovation. The paper describes actor-network theory, an approach originating in studies of science and technology, and how it might be used in studying technological projects. It also offers the theory of innovation translation, informed by actor-network theory, as an alternative to innovation diffusion in understanding issues of information systems implementation.

Keywords

IS Research Methodology, Research Methodology, Socio-Technical Approach, Technological Innovation

INTRODUCTION

Each field of academic inquiry is characterised by its own preferred and commonly used research methodologies. Several years ago in a survey of published MIS articles in selected Information Systems journals Orlikowski and Baroudi (1991) found that 96% of their sample adopted a positivist perspective while the remainder were interpretive. Building on a research taxonomy developed by Hamilton and Ives (1982), Farhoomand (1992) has classified IS-related research papers published in a similar set of journals in the 1980s into five categories: case study, survey, field test, experimental and non-empirical research. Farhoomand reports that 57% of his sample consisted of empirical research with case studies and surveys constituting the majority of this. A more recent examination of the literature however, suggests that the percentage of interpretive research published since that time has increased markedly.

In the late 1980s, Galliers and Land (1987) deplored the tendency of IS researchers to accept the primacy of traditional, empirical approaches that they saw as more appropriate to the natural sciences than to studies of organisational use of information. In line with this Hirschheim (1992), Nissen et al. (1991), and Achterberg et al. (1991) have argued for a shift in IS research towards a broader perspective with the acceptance of methodological pluralism. Partly as a result of these efforts, since the early 1990s qualitative research has gained considerably in legitimacy and is now used much more extensively in investigating information systems.

In this paper we will advocate the addition of actor-network theory (ANT), an approach developed by scholars including Latour, Callon and Law from the study of science and technology, to the qualitative research traditions presently used in information systems research. We will show how actor-network theory can form a framework that can be useful for studying the implementation of information systems.

RESEARCH TRADITIONS IN INFORMATION SYSTEMS

A methodology can be regarded a philosophical framework, or 'point of view' (Deely 1990), within which a set of methods can be systematically applied (Guba and Lincoln 1988). In relation to qualitative research in Information Systems, Orlikowski and Baroudi (1991) offer three philosophical perspectives: positivist, interpretive and critical research. Myers (1997) describes the stance taken by positivist researchers in Information Systems as based upon the assumption that reality is objectively given and that it can be described by reference to measurable properties that are independent of the researcher. Interpretive IS researchers, on the other hand, consider that reality can only be accessed through social constructions such as language, consciousness and shared meanings. Critical research makes the assumption that social reality is historically constituted and that people are constrained in their actions by various forms of cultural and political domination (Myers 1997).

Myers (1997) outlines four qualitative traditions as being particularly significant in Information Systems research: case study research, ethnography, grounded theory and action research. According to Orlikowski and Baroudi (1991) and supported by Alavi and Carlson (1992) case study research is the most commonly used qualitative approach in Information Systems. They suggest that as IS research topics commonly involve the study of organisational systems, a case study approach is often quite appropriate. Many of the case study researchers in Information Systems takes a positivist perspective (Benbasat, Goldstein et al. 1987; Lee 1989; Yin 1994), but some instead adopt an interpretive stance (Walsham 1993; 1995) while others, like Kaplan (1988), advocate a middle course involving a combination of qualitative and quantitative methods.

LIMITATIONS OF EXISTING RESEARCH APPROACHES

A common approach to researching innovation in Information Systems is to focus on the technical aspects of an innovation and to treat 'the social' as the context in which its development and adoption take place. Technological determinist approaches of this type which contend that only the 'most appropriate' innovations are adopted, and that only those 'sensible people' who make these adoptions go on to prosper, assume that all outcomes of technological change are attributable to the 'technological' rather than the 'social' (Grint and Woolgar 1997). At the other extreme is social determinism which holds that relatively stable social categories can be used to explain technical change (Law and Callon 1988), and concentrates on the investigation of social interactions, relegating the technology to context; to something that can be bundled up and forgotten. This bundling means that fixed and unproblematic properties, or 'essences' can then be assigned to the technology and used in any explanation of change.

Many approaches to technological innovation are based on the premise that the systems or entities under consideration have some essential nature or capacity that determines how they operate. Soft systems methodology, for instance, takes this stance. We will argue that essentialist approaches like this present difficulties when crediting certain actors and entities with essences or properties that determine how they will behave in particular circumstances.

Brey (1997) proposes that rather than relying on some 'inner technological logic', technological change is best understood by reference to technological controversies, disagreements and difficulties with which the actors involved in the change are concerned. He argues for an approach using some form of social constructivism in which the researcher does not need to evaluate claims made by different groups about any 'real' properties of the technology being studied. He cautions, however, that if an approach like this is used one cannot then invoke such properties to explain technological change. Change must be explained, instead, by interpretations of the different groups involved in it, after a series of controversies and negotiations. Brey then classifies social constructivist approaches into three groups: strong social constructivism, mild social constructivism, and actor-network theory.

In strong social constructivism, which is aligned most closely with the sociology of scientific knowledge (SSK) approach of scholars like Collins, technology is explained as a social construction, and technological change by reference to social practices such as interpretation, negotiation and closure of the actors involved. It supports a division between social, natural and technical entities but attributes no properties, powers or effects to the technology itself. Approaches using mild social constructivism, often going under the name 'social shaping', retain conventional distinctions between the social, natural and technical, and attempt their explanations by examining ways that social factors shape technology. Social shaping does allow a role for non-social factors in technological change but is also willing to attribute properties and effects to the technology although it claims that, as technology is socially shaped, these properties and effects are largely built-in through factors relating to the social context (Brey 1997).

Latour et al (1992) note that the issue of anti-essentialism, in the sense of there being some difference in essence between humans and non-humans, is a major contention between actor-network theory and the sociological position of SSK. They suggest that in SSK it is necessary to recognise in advance the essences of humans and of social organisations and to distinguish their actions from the inanimate behaviour of technological and natural objects. Actor-network theory sees things quite differently as Latour, Mauguin et al. (1992 :56) argue: "We believe that both essence and differentiation are the result of attribution work and can be studied empirically."

There are two main ideas here: in many methodological approaches we think in binaries which often leads us to designate an entity as either technological or social, and then we attribute specific properties to that entity in order to explain its behaviour, thereby adopting an essentialist position. Studies that follow grounded theory often adopt this approach, but actor-network theory does not distinguish between the social and technological and sees properties as network effects rather than innate characteristics of an entity.

ACTOR-NETWORK THEORY: A NEW APPROACH

Actor-network theory declares that the world is full of hybrid entities (Latour 1993) containing both human and non-human elements, and was developed to analyse situations where separation of these elements is difficult (Callon 1997 :3). One could question, for instance, which part of a piece of software is just an inanimate object and which the result of human interactions. It is difficult to differentiate a computer program's technical aspects from the influence exerted by the socio-cultural background of the software development team (Cusumano and Selby 1997; Sahay 1997). What seems, on the surface, to be social is partly technical, and what may appear to be only technical is partly social. ANT deals with the social-technical divide by denying that purely technical or purely social relations are possible. It offers the notion of heterogeneity to describe projects such as one using a programming language, database management system, barcode scanner, human programmer and operator in the construction of a computer system for use in stock control in a supermarket. The use of heterogeneous entities (Bijker, Hughes et al. 1987) then avoids questions of: 'is it social?' or ‘is it technical?’ as missing the point, which should be: “is this association stronger or weaker than that one?” (Latour 1988b :27). ANT considers both social and technical determinism to be flawed and proposes instead a socio-technical account (Latour 1986; Law and Callon 1988) in which neither social nor technical positions are privileged. Latour (1991 :117) argues that: “Contrary to the claims of those who want to hold either the state of technology or that of society constant, it is possible to consider a path of an innovation in which all the actors co-evolve.”

To address the need to treat both human and non-human actors fairly and in the same way, ANT is based upon three principles: agnosticism, generalised symmetry and free association (Callon 1986b). The first of these tenets, agnosticism, means that analytical impartiality is demanded towards all the actors involved in the project under consideration, whether they be human or non-human. Generalised symmetry offers to explain the conflicting viewpoints of different actors in the same terms by use of an abstract and neutral vocabulary that works the same way for human and non-human actors. Neither the social nor the technical elements in these ‘heterogeneous networks’ (Law 1987) should then be given any special explanatory status. Finally, the principle of free association requires the elimination and abandonment of all a priori distinctions between the technological or natural, and the social (Callon 1986b; Singleton and Michael 1993).

In summary, under the principles of agnosticism, generalised symmetry and free association, actor-network theory attempts impartiality towards all actors in consideration, whether human or non-human, and makes no distinction in approach between the social, the natural and the technological. As Callon (1986b :200) puts it: “The rule which we must respect is not to change registers when we move from the technical to the social aspects of the problem studied.”

Callon (1987) further proposes that entities become strong by gathering a ‘mass of silent others’ to give them greater strength and credibility. A network becomes durable partly due to the durability of the bonds that hold it together, but also because it is itself composed of a number of durable and simplified networks. The solidity then results from a structure where each point is at the intersection of two networks: “one that it simplifies and another that simplifies it.” (Callon 1987 :97) Care is, however, needed with the term network here as it is used in a special way to describe shifting alliances of actors and not some fixed thing. Entities that comprise networks are often converted into inscriptions or devices (Callon 1986a) such as documents, reports, academic papers, models, books, and computer programs. Latour uses the term ‘immutable mobile’ to describe these things as when they are moved around they remain stable and unchanged (Singleton and Michael 1993; Mol and Law 1994).

Once a network is formed, however, that is not the end of the story as networks are always unreliable and can become unstable. The entry of new actors, desertion of existing actors or changes in alliances can cause the ‘black-boxes’ (Callon 1986a) of networked actors to be opened and their contents reconsidered. A network relies on the maintenance of its simplifications for its continued existence. These simplifications are under constant challenge and if they break down the network will collapse, perhaps to re-form in a different configuration as a different network.

In an object-oriented programming environment each component of the computer program can be considered as an object (Parsons and Wand 1997) with its own properties, methods and actions. In common with the encapsulation of objects in object-oriented environments the actors, or ‘heterogeneous entities’ (Bijker, Hughes et al. 1987), encountered in actor-network theory have attributes and methods and may themselves be composed of other objects or actors. So, when looked into carefully, an actor itself consists of a network of interactions and associations. In the same way, a network may be simplified, or black-boxed, to look like a single point actor (Law 1992).

A feature of actor-network theory is its dislike of large scale, 'obvious', tautological answers to problems; answers like "the thing doesn't work because it couldn't have worked" (Latour 1996 :121) or 'Visual Basic was adopted because its time had come', or 'Java developed enough momentum to make its use inevitable'. It prefers instead to look at the suggestions offered by the actors themselves. It insists that, apart from the capacity of actors to negotiate with and enrol other actors, no a priori assumptions are made about the matter under investigation, and attempts an understanding on the basis of studying the set of complex negotiations and trade-offs performed by the actors.

An actor is not just a 'point object' but an association of heterogeneous elements themselves constituting a network, so each actor is also a simplified network (Law 1992). An actor can, however, in many ways also be considered as a black-box, and when the lid of the box is opened it will be seen to constitute a whole network of other, perhaps complex, associations (Callon 1986a). In many cases, details of what constitutes an actor - details of its network - are a complication we can avoid having to deal with all the time. We can usually consider the entity just as an actor, but when doing this it must be remembered that behind each actor there hide other actors that it has, more of less effectively, drawn together (Callon 1987). This means that any changes affect not just this actor, but also the networks it simplifies. It is, likewise, often also possible to 'punctualise' (Law 1992) a stable network and so consider it in the form of a single actor. Whenever possible it is useful to simplify, to an actor, a network that acts as a 'single block' to make it easier to deal with. An actor then "... can be compared to a black-box that contains a network of black-boxes that depend on one another both for their proper functioning and for the proper functioning of the network." (Callon 1987 :95)

Actor-network theory, or the 'sociology of translations' (Callon 1986b; Law 1992), is concerned with studying the mechanics of power as this occurs through the construction and maintenance of networks made up of both human and non-human actors. It is concerned with tracing the transformation of these heterogeneous networks (Law 1991) that are made up of people, organisations, agents, machines and many other objects. It explores the ways that the networks of relations are composed, how they emerge and come into being, how they are constructed and maintained, how they compete with other networks, and how they are made more durable over time. It examines how actors enlist other actors into their world and how they bestow qualities, desires, visions and motivations on these actors (Latour 1996). Law and Callon (1988 :285) put it this way: "Our object, then, is to trace the interconnections built up by technologists as they propose projects and then seek the resources required to bring these projects to fruition."

ANT shares fundamental principles with other qualitative approaches, and especially with ethnography. Like ethnography, actor-network theory is useful in handling complexity without simply filtering it out. After some early work such as that undertaken by Suchman (1987) and Zuboff (1988) the prominence of ethnography as a suitable approach to Information Systems research has risen. Ethnography has been used especially in research where the emphasis is upon design, computer-supported cooperative work, studies of Internet and virtual communities, and information-related policies (Star 1995). Some ANT writers (Law 1994) also derive their research method from that of ethnography.

Actor-network theory has been used to investigate the success of a number of technological innovations and, in particular, to describe a number of heroic failures, several of which are listed below. Grint and Woolgar (1997) have used ANT to explain the Luddite movement in England last century. McMaster et al. (1997) have applied it to the adoption of a particular approach to systems analysis by a local council in the UK, and Vidgen and McMaster (1996) to car parking systems. Latour (1988a) has used actor-network theory to discuss the achievements of Louis Pasteur, some of the processes undertaken by scientists in their research and their laboratories (Latour 1987), the simultaneous invention of the Kodak camera and the mass market for amateur photography (Latour 1991), and the life and death of the revolutionary Parisian public transportation system known as Aramis (Latour 1996).

UNDERSTANDING INNOVATION AS AN ACTOR-NETWORK

An innovation has be described as an idea that is perceived to be new to a particular person or group of people (Rogers 1995). Implementation of an Information System thus inevitably involves innovation as the system will almost always be seen as new by at least some of its users.

By far the dominant paradigm in innovation research is that of innovation diffusion (Rogers 1995) in which the four main elements are: characteristics of the innovation itself, the nature of the communication channels, the passage of time, and the social system. Using this approach in an explanation of the successful adoption, or rejection, of an IS innovation the researcher would concentrate on things like details of the new system itself, how the change agents helped in its adoption, why users accepted or resisted the implementation, and over what time period this all occurred. An alternative view of innovation is that proposed in actor-network theory and the core of this approach is translation (Law 1992) that can be defined as: "... the means by which one entity gives a role to others." (Singleton and Michael 1993 :229)

Callon et al. (1983) propose that translation involves all the strategies through which an actor identifies other actors and arranges them in relation to each other. Latour (1996) speaks of how 'chains of translation' can transform a global problem, such as the transportation needs of a city like Paris (or the design of the a new information system) into a local problem like continuous transportation (or using Visual Basic to obtain data from an Oracle database).

The model of translation as proposed in actor-network theory proceeds from a quite different set of assumptions to those used in innovation diffusion. Latour (1986) argues that the mere 'possession' of power by an actor does not automatically confer the ability to cause change unless other actors can be *persuaded* to perform the appropriate actions for this to occur. The notion that power is an attribute that can be possessed by an actor is an essentialist one, and Latour contends that rather than this, it is the number of other people who enter into the business that indicate the amount of power that has been exercised (Latour 1986). He maintains that in an innovation translation model the movement of an innovation through time and space is in the hands of people each of whom may react to it in different ways. They may modify it, deflect it, betray it, add to it, appropriate it, or let it drop (Latour 1986). He adds that this is true for the spread of anything from goods and artefacts to claims and ideas. In this case, the adoption of an innovation comes as a consequence of the actions of everyone in the chain of actors who has anything to do with it. Furthermore, each of these actors shapes the innovation to their own ends, but if no one takes up the innovation then its movement simply stops; inertia cannot account for its spread. Instead of a process of transmission, we have a process of continuous transformation (Latour 1996) where faithful acceptance involving no changes is a rarity requiring explanation. "Instead of the transmission of the same token – simply deflected or slowed down by friction – you get ... the continuous transformation of the token." (Latour 1986 :286)

McMaster et al. (1997) add that innovations do not wait passively to be invented or discovered, but are instead created "... from chains of weaker to stronger associations of human and non-human alliances. ... Each actant *translates* and contributes its own resources to the shape and ultimate form of the emerging black box." (McMaster, Vidgen et al. 1997 :4) This occurs, they note, by virtue of the 'relative convergences' of their respective interests. The amount of control that can be exercised by any individual actor over this process is, of necessity, limited as translation "entails metamorphosis and loss of sovereignty" (McMaster, Vidgen et al. 1997 :4) no matter how much this actor wants to retain control. Latour (1986) stresses that it is not just a matter of each of the actors in the chain either resisting the innovation or transmitting it in the same form that they received it, but that their shaping of the innovation is essential for its continued existence. In this they are actors, not just clients, and everyone involved translates, or shapes, the innovation according to their own needs. In doing this, the converging interests of these actors, that at first are only "an assembly of disorderly and unreliable allies", slowly evolves into "something that closely resembles a black box" (Latour 1987 :130-131). The addition of each new ally contributes to the ultimate form of the emerging black box (McMaster, Vidgen et al. 1997) as the chain is strengthened and the network lengthens over space and time due to the translation of the innovation. A translation model requires the focus to be on understanding how actor-networks are created, strengthened and weakened, rather than on causes and effects.

The key to innovation is the creation of a powerful enough consortium of actors to carry it through, and when an innovation fails to be taken up this can be considered to reflect on the inability of those involved to construct the necessary network of alliances amongst the other actors (McMaster, Vidgen et al. 1997). Getting an innovation accepted calls for strategies aimed at the enrolment of others in order to ensure the creation of the black box. Latour (1986) suggests that this is done by 'interesting' others and then getting them to follow our interests, so becoming indispensable to them. This process is facilitated if other possibilities are first blocked off and: "The work of generating interest consists in constructing these long chains of reasons that are irresistible, even though their logical forms may be debatable." (Latour 1996)

In comparing the diffusion and translation models, Latour (1986) contends that in a diffusion model, an innovation is endowed with its own form of inertia and propelled from a central source. This enables it to move through space and time without the need for further explanation and makes it unstoppable except by the most reactionary interest groups. In fact what needs to be explained, he suggests, is its acceleration or slowing down which must then be due to people: an effective change agent or a backward culture. Diffusion models, he notes, define three important elements in the movement of an innovation: the initial force with which it is launched, the innovation's inertia, and the medium through which it moves. Once the innovation has been pointed out to people, then it should just be a matter of time before everyone, except the most immovable, recognise its worth (McMaster, Vidgen et al. 1997). The advantage of a diffusion model is that anything can be easily explained by reference to the initial force or the resisting medium (Latour 1986).

There are occasions, however, when diffusion does not occur despite the excellence of the idea or the technical quality of the innovation. The non-diffusion of the Dvorak keyboard is just such an example and Rogers (1995) suggests that the Dvorak keyboard failed, despite its 'obvious superiority' over the QWERTY keyboard, because of 'vested interests' supporting its rival. Actor-network theory, on the other hand, would argue that the Dvorak keyboard was not adopted because there were just too many things attached to use of the QWERTY keyboard; it had too many associations to make it feasible for the Dvorak keyboard to un-attach them.

Latour (1996) contrasts innovation diffusion with the translation model in which the initial idea hardly counts and the innovation is not endowed with autonomous power or 'propelled by a brilliant inventor'. The innovation has no inertia and moves only if it interests one group of actors or another. Its movement cannot be caused by an initial impetus as there is none. It is instead a consequence of energy given to it by everyone in the chain. When the innovation does interest a new group they transform it a little or perhaps a lot. Latour notes that, except in rare cases, there can be 'no transportation without transformation', and that "... after many recruitments, displacements and transformations, the project, having *become* real, then manifests, perhaps, the characteristics of perfection, profitability, beauty, and efficiency that the diffusion model located in the starting point." (Latour 1996 :119)

An actor-network is configured (Grint and Woolgar 1997) by the enrolment of both human and non-human allies, and this is done by means of a series of negotiations in a process of re-definition in which one set of actors seek to impose definitions of the situation on others (Callon 1986b). Translation can be regarded as a means of obliging some entity to consent to a 'detour' (Callon 1986a) that takes it along a path determined by some other entity. Law (1987) uses the term 'heterogeneous engineer' to describe the entity that designs and creates these detours. A heterogeneous engineer is then able to speak on behalf of other actors enrolled in the network. A network becomes durable when actors feel no need to spend time opening and looking inside black-boxes, but just accept these as given.

As an example of how this might be applied in an information systems implementation, consider the adoption of Java in a particular systems development project in a situation where the consultants had no previous experience of this language. An innovation diffusion approach would, in outline, begin with a consideration of the characteristics of Java including its evolution from C++, its degree of object-orientation, the portability of its applications, and so on, and how these characteristics might help or hinder its adoption. It would then look at the channels through which information about the innovation reached the developers: the computer press, university or training courses, friends from other companies, etc, and how effective these were in delivering the message. Next it would consider aspects of the development company relating to its programming 'culture'; things like what programming languages had been used in the past, the background of the programmers, and the type of applications they had previously developed.

On the other hand, innovation translation would concentrate on issues of network formation. It would investigate the alliances and networks built up by the consulting company, their programmers, Java, the potential users, and other actors involved in the implementation. It would concentrate on the negotiations that allow the network to be configured by the enrolment of both human and non-human allies, and would consider Java's characteristics only as network effects resulting from association. Actor-network theory would suggest that it is not any innate properties of Java that are important, but rather network associations such as Java's possibilities for the creation of Web applets and portable applications that are the significant factors in its adoption. It would look at the process of re-definition in which Java sought to impose definitions of portable applications and Web programming on others; how it 'interested' the programmers and then got them to follow its interests so becoming indispensable to them. In this case what is then finally adopted for this task is not Java as such, but a *translation* of Java in which it becomes a programming language for use with Web applications.

CONCLUSION

Actor-network theory draws on the strengths of qualitative research to provide a powerful, but somewhat different framework for understanding IS innovation. In refusing to accept the social/technical divide, and by treating human and non-human actors impartially, it avoids the essentialism, lack of heterogeneity and explanation by use of binaries that are inherent in many other methodologies. As an alternative to innovation diffusion, a theory of innovation translation offers an approach to explaining innovation that does not rely on any supposedly innate nature of the innovation, or specific characteristics of the change agents or society, but rather on a process of network formation in which all actors seek to persuade others to become their allies in promoting the acceptance of their own view of the way the problem can best be solved. Actor-network theory offers advantages over other IS research methodologies, particularly in situations where 'political' considerations are important.

Methodologies such a grounded theory lend themselves to essentialist descriptions of phenomena arising out of the coding process. Open, closed, axial and systematic coding with their reliance on the concepts of categories, properties and dimensions lead us to think about innate properties rather than properties arising out of negotiation.

Actor-network theory extends ethnography to allow an analysis of both humans and technology by using a single register to analyse both, so avoiding the need to consider one as context for the other. It helps the researcher not to think in terms of human/non-human binaries and the different discourse with which each may be aligned. An actor-network analysis of information systems innovation may well be described as an ethnography but one that develops themes that conceptualise people and artefacts in terms of socio-technical networks, thus employing concepts such as networks, enrolments and actors.

Case study methodology tends to set prior boundaries for the study of a case even though the parameters of the case may change during the study. An ANT analysis establishes boundaries only as the investigation of the negotiations involved unfolds and the associations between actors are positioned in the narrative for the development of the information system.

Unlike action research, actor-network theory is not concerned with emancipation of the researcher or practitioner and is not focused on making us better at developing information systems. Nevertheless, an ANT analysis may provide us with the detail to understand the success or failure of a particular innovation.

We contend that actor-network theory can be useful for studies of information systems in situations where interactions of the social, technological and political are regarded as particularly important. It is not that ANT is of no use in predominantly technical situations, but we see it as of more use in situations where the researcher needs to develop an holistic narrative that relies on the use of a common register to investigate the contributions of each of these factors. We thus suggest that actor-network theory, and the theory of innovation translation, can be particularly useful for studies in areas such as business use of the World Wide Web, issues in IT project management, computer-based collaborative work, interface design, usability testing, the use of distributed systems within organisations and other areas that involve a consideration of some of the social and political issues in information systems. We suggest that ANT has something useful to offer to information systems research, particularly in areas like these, and that more attention should be given to use of this approach.

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