Varieties of Actor-Network Theory in Information Systems Research

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Abstract: In the last two decades Actor-Network Theory (ANT), which originated in Science and Technology Studies in Paris, has been used as a framework for interpretive research in a number of areas, including history, ecology, transport studies and health studies. In this paper we describe how a number of projects used ANT for research into the development and use of information systems (IS).
ANT has never been clearly defined, and is certainly more an attitude than a theory or methodology. One of its chief characteristics is an insistence on symmetry or even-handedness. Equal attention is given to explanations of success and failure, to the concerns of humans and non-humans, and to very broad and extremely detailed views. The features of a particular case always dominate, and the number of general theories is minimal. This leads to a wide variety of "schools", interpretations and methods. Three major concerns are the spread and interpretation of scripts (in the earlier work of Latour), the enrolment of the necessary actors in a project (Callon), and the dissemination of an actor network as a complete package, a black box (Law's immutable mobiles). Questions of adoption and enrolment have been of particular interest in IS research, with applications in such areas as the introduction of technology into developing countries, the adoption of standards, and the acceptance of integrated IS solutions (enterprise resource planning packages).
The cases discussed in this paper include a strategy for flexible learning in a university, the installation of packaged software in a large company, the introduction of an intranet in a media organisation, and the introduction of a university institutional repository. Each of the research projects took a different aspect of ANT as its starting point, but all used the basic strengths of ANT to give new insights into other wise intractable phenomena. These projects suggest a variety of suitable approaches for those wishing to use ANT as a guide in their research journey.

Keywords: actor-network theory, information systems, adoption, interpretive research.

1. Features of ANT

ANT arose as a framework for interpreting research in science and technology studies. In attempting a sociological study of scientists in their laboratories, it became apparent that equipment, chemicals and scientific theories played more than passive or contextual roles in the trajectory of laboratory culture (Latour and Woolgar, 1979). To make sense of the work of the scientists, the sociologists had to understand the interactions of humans, institutions, technical artifacts and concepts. This eventually led to an emphasis on *symmetry* or, as Latour later recast it, not imposing "a priori some spurious *asymmetry* among human intentional action and a material world of causal relations" (Latour 2005 p 76). Adding an intentional framework to our views of non-humans blurs the distinction between empiricism and constructivism and allows us to trace the success or otherwise of particular objects/concepts such as oxygen (Latour 1987) or particular socio-technical projects such as an innovative urban transit system (Latour 1996). The participants, human or otherwise, in the project, the evolution of a theory or the work of a laboratory, are called the *actors*. It is important that they be thought of as *mediators*, that transmit effects on their own terms, that may or may not co-operate, rather than *intermediaries*, passive links in causal chains (Latour 2005 p 105).

For a project to exist, for a theory to develop, the actors must assemble into a *network*, a loose, dynamic, always tentative collaboration. From the point of view of a particular actor (perhaps a project manager) who is trying to promote some idea, action or value, the objective is to assemble a network of allies. In his study of the development of a farmed scallop fishery, Callon (1986) proposed four stages in the development of networks, *problematisation, intéressement, enrolment* and *mobilisation*, which move from getting the issue onto the agenda to having the final product accepted as a "matter of fact" or a *black box*, something which is no longer questioned. Callon called this process of assembling a network *translation*; at this level it is unremarkable, something that has been addressed from Machiavelli through to n-person game theory. The contributions of ANT are in its insistence on symmetry and on operationalising the assembly of allies. Thus, in the case of *Aramis*, the system of loosely coupled urban trains, the system itself was seen as an actor that was trying to come into being (a very useful way of conceptualising something that is in the process of being

designed). The system failed because, although various parts such as couplings, motors and carriage bodies were able to enrol allies, the system as a whole could not. This example illustrates three instances of symmetry: the intentionality of non-humans (even those that do not yet exist), actors that act independently, even though they are parts of other actors, and narratives that take the same form, irrespective of whether the outcome is success or failure.

To operationalise alliances, Latour's early work relied on the idea of *inscription* (Latour 1992). An actor may have a script they wish to implement, such as "be aware of intruders". We might implement this script alone (by staying awake and alert), or we might conscript a network of allies, each of which might need to implement a related script ("increase the output voltage when motion is detected", "SMS this number when voltage increase is detected", "make sound when SMS is received"). Here we have a second, lower level, more operational meaning of *translation*. Making an alliance involves the translation of one actor's script into something that another actor will understand and be willing and able to implement. An obvious example is programming a computer to perform some task. Despite what computing texts may say, those of us who have attempted this are only too aware that the computer is a true mediator, that it may or may not do what we tell it.

This suggests one way of studying the development and maintenance of actor-networks is to "follow this scripts", looking in detail at how they are translated (or betrayed, another example of symmetry - Underwood 2001). This might involve looking in detail at conversations, emails, manuals and other types of text. Latour (2005), instead, suggests we "follow the actors", but the effect is similar (and scripts could be seen as actors as well). In any case, the important thing is to follow where the situation leads us, across boundaries, across ontological categories and across levels, rather than to fit the data to some pre-conceived framework. This suggests a similarity with the grounded theory approach (Glasser 1998), but ANT concentrates on the narrative and delays the construction of any theoretical model; there is an obstinate insistence on the details of the particular (Bakhtin 1993).

2. Concerns of IS Research
The field of Information Systems is interested in information technology (IT) in use. This may mean individuals using particular hardware or software as part of their work (Suchman 2007) or play (Carroll 2004), the impact of IT on the strategy or success of particular organisations or of industry sectors in general (Willcocks and Lester 1999), or the way in which computer-based information systems are designed, developed and put into use (Avison and Fitzgerald 2006). IS teaching and research has two distinct though always overlapping and now converging ancestries: in the Western hemisphere IS arose in business schools, has been mainly concerned with strategic, economic and governance issues, and has favoured survey research, while in the Eastern hemisphere IS existed (mostly unhappily) in computer science schools, was concerned with development tools and methods, and often used case study research. While the Western researchers drew to some extent on the theories and methods of other business researchers (economics, psychology. sociology) those of the East dabbled in information theory, operations research, systems theory and a variety of other possible foundations for their discipline. Many of these researchers had experience with business analysis activities in the IT industry and were fairly confident that they could find out what was going on and what was needed; they had difficulty, however, in developing underlying theories and in making their work academically respectable.

This unsatisfying search for theory may explain why ANT is gradually increasing in popularity among IS researchers. The method of following the actors is familiar to business analysts, the lack of an explicit theory is attractive to those trying to avoid the imposition of abstract formalisms, and the ontological liberalism is refreshing to those who are used to constantly switching their attention from strategic management issues to detailed technical questions.

One of the earliest uses of ANT in IS research was a study conducted by Woolgar (1996) in a software development company, where management, technicians, users and the technology all attempted to inscribe their needs in each new version of the software. Bloomfield and Vurdubakis (1994), using ANT combined with Foucault's theory of power/knowledge, showed how hospital management blocked the interests of doctors by placing design discussions within technical discourse. In Norway ANT has been used to study the design of IT infrastructure (Monteiro and Hanseth 1996), the implementation of an SAP system (Hanseth and Braa 1998), and the development of new internet standards (Hanseth and Monteiro 1997, Monteiro 1998). Tatnall has used ANT to study the adoption of IT in a variety of rural and community situations (e.g. Everitt and

Tatnall 2003); a general framework for evaluating IS adoption, based on Callon's stages of network translation, was developed by McMaster, Vidgen and Wastall (1998). The ability of ANT to consider simultaneously different levels of detail was used by Young and Letch (2003) to understand different knowledge management perspectives within an organisation.

In the following sections we describe recent and current Australian projects using ANT to understand various aspects of IS development.

3. The role of concepts in (mis)understanding scripts

This project (Underwood 2001) was motivated by a desire to clarify the apparently common misunderstandings between users and systems developers over information systems requirements. Traditionally requirements have been represented by a text, a combination of natural language, diagrams and formal specifications, which is agreed to by users and developers (Avison and Fitzgerald 2006). Alternative approaches involve evolving design through ongoing and open discussions among stakeholders (Checkland and Scholes 1990) or the use of prototype systems to test user acceptance (Beck 2000). Nevertheless, many IS development projects fail, and the most common cause is unclear or changing requirements (Fitzgerald, Phillipides and Probert 1998).

The case studied was a pilot flexible learning project undertaken at an Australian tertiary institution with the support of a small grant. The initial research approach was based on Foucault's (1972) theory of discourse because it was assumed that developers and users were interpreting requirements texts within different professional discourses. Texts were searched for what were assumed to be key terms (such as "flexible learning") to see if they appeared in different contexts but, surprisingly, they seldom appeared at all. The next step attempted to use the "genealogical" aspect of Foucault (1980), to see how power and discourse interacted at the micro level, in meetings and email exchanges. As this was a project undertaken more or less voluntarily by peers there was no pre-defined power structure, but there was evidence of people influencing discourse through control of meeting minutes and knowledge of the views of top management, and of some more technically oriented stakeholders losing power because they were uncomfortable with educational discourse. Foucault does not, however, let us understand the details of how these exchanges play out.

It was at this stage that ANT was "discovered" by the researcher. This allowed the identification of a number of scripts that the various actors were promoting, and it was possible to track these scripts through meetings and email exchanges where some survived and some perished. The next question was, how were these scripts translated as they moved from one actor to another; an alliance means agreeing to support a script, but what was being agreed to? In some cases actors found a common discourse (such as academic life or project planning and budgetting) within which to share understanding of scripts; in some cases the scripts were talked about loosely, until shared practical understanding made them part of an unique local discourse; and in some cases actors just agreed to disagree. This explains why apparently key terms seldom appeared in the texts; interviewees indicated that the terms were deliberately avoided because they were too controversial.

Overall it appeared that actors preserved their scripts by tolerating ambiguity well into the enrolment stage and perhaps into mobilisation. This made life difficult for the more technically oriented actors (human and non-human) as they were less tolerant of ambiguity. Another observation was that although almost all actors had expected the project to result in some sort of software, the actual outcome was a booklet of references, hints, and sources of support. Nevertheless, most actors regarded the project as a success, including the sponsor who supplied the grant. This supports the interpretation that actors' understandings of their scripts remained ambiguous until they had seen the final outcome.

4. Networks of success and failure

The next project (Abrahall 2005) used ANT to explain success and failure in a large IT project developed for the Australian arm of a global insurance company. During the research, the researcher was involved in a minor role in the later stages of the project, but the research findings were based mainly on an analysis of documents and interviews. It was decided at an early stage to use ANT as the research approach.

The IT project was developed in two stages. A large proportion of the development work was outsourced and a commercial package was used to apply the business rules. The first stage was

partly motivated by a change in support provided by the company's telecom provider; it was finished almost on time, but was well over budget, had reduced functionality, poor performance and serious instability. Nevertheless, it showed that the clients wanted this type of system, and enabled the company to dramatically increase its market share. For some actors the objective of phase 2 was to repair the phase 1 system, while for others, who proclaimed phase 1 a great success, it was to extend the functionality of phase 1 and maintain their competitive advantage over other insurers. At great expense stage 2 did repair the system, but did not achieve any explicit strategic goals.

ANT was used to show how the ambiguous outcomes resulted from a failure to achieve a suitable stable actor-network for the development process. The analysis shows how the relevant network changed as the project progressed. In the previous (and future) stable system, the telecom supplier was an obligatory point of passage (OPP - Callon 1986), so that when they changed their software the insurance company was forced to respond; at the next stage the business plan, the deadline (imposed by the telecom's decision), the project owner and the company's IS architects were the dominant actors. Once the commercial software package had been chosen as the basis for the system, the telecom's software receded into the background and the commercial package became an OPP for all decisions; by enrolling suitable allies, this package remained as an OPP during the design and development of phase 2. Other key actors during phase 2 development were the online development team, the mainframe architects, the business experts and "integration" (the task of making it all fit together). The business experts (of whom there were only two) needed to communicate with all other actors, but for a variety of organisational and personal reasons this was not achieved. The online development team (or parts of it) did communicate with almost all other actors, but the team itself was an unstable network. "Integration", on the other hand, was seen as a technical issue, and only communicated directly with technical experts. Given that one of the objectives of the IS architects was to produce a modular system, this was a serious problem.

In general business management and some external consultants formed strong alliances with the commercial package and the company supplying it, while the insurance company's IS architects and other external consultants were only very reluctantly enrolled. This might explain why the business sponsors saw the project as a success (except for the enormous cost) while most technically oriented actors saw it as a failure.

5. Due process for successful networks

In the previous case, network stability arose in part from potentially key actors who were left "out of the loop". The case studied discussed in this section (Tabak 2007) differs in that the researcher intended to use ANT from the beginning, he attempted to use the lessons of ANT to influence an IS development project in which he was actively involved, and he was particularly concerned with "due process" (McMaster, Vidgen and Wastell 1998) in the construction of actor networks.

The researcher, who had background in both librarianship and IT, was the internet content manager for a large Australian entertainment company. Since the company's products were constantly changing, the internet site was dynamic and well maintained. Employees often discovered things from the internet that were difficult to discover otherwise. A plan evolved to use the techniques learned from developing the internet as the basis for a company knowledge support system. The employees were a mixture of creative designers and financial controllers. Even in more homogeneous organisations knowledge management initiatives face two major problems: getting people to contribute to the knowledge base, and classifying items so that they may be found by people to use on projects that hadn't been thought of at the time the data were collected. Thus the idea of non-purposive information behaviour (Olsson 2004) was crucial to the project, as was the enrolment of as many as possible of the staff.

Research data was collected by semi-structured interviews, supported by observation and the researcher's self-reflection. A key part of the analysis was the development of a diagrammatic model that integrated Callon's stages of translation with the due process model of McMaster, Vidgen and Wastell. Information from the interviews was eventually summarised as a sequence of due process diagrams for each of the proposed or eventual functionalities of the knowledge support system; some functions survived, some disappeared, and some transformed into something more feasible, technically or politically. Each individual due process diagram shows a function attempting to conscript allies at one of the stages of translation of the overall project; sometimes a function failed to assemble a coalition of allies, sometimes it succeeded, perhaps leaving some potential allies behind,

and sometimes it became an established fact or goal without stabilising its coalition, thus carrying instability on to the next stage. It was observed that the latter case was often associated with one actor or small group of actors attempting to impose their vision on the project.

This case also showed the importance of concepts and even names as actors. As this project originated from the operational levels of the organisation it was unlikely to be called "knowledge management system", but the first attempt was "organisational web portal". This was doomed to failure, since management was only too aware of a previous public web portal project that had been an expensive failure. After initial rejection, a number of apparently unrelated initiatives were tried in different parts of the organisation, and these gradually coalesced into the "[company name] intranet".

Concepts act in the network to represent various discourses - they are a type of shorthand loaded with value and theory, and hope to clarify project development while gaining allies in a wider network. The discussion of non-purposive information behaviour introduces concepts such as "serious leisure" and "reading for pleasure" (Olsson 2004) which come from discourses of the academy and the library. These concepts were not embraced in an organisation whose dominant discourses were marketing and sales. Although much non-purposive information behaviour was observed, it was not valued by the organisation. The researcher attempted to promote the value of "ambiguity" in designing a system to support non-purposive information behaviour, but again this was a concept that was unable to gain allies in management (Tabak pers comm). The irony was that while there was no support for ambiguity as a design criterion, the success of the project depended on ambiguity and non-dominant discourses. The intranet began as a collaboration between the customer service and design departments, which were anchored in alternative discourses (although one might imagine that this is what an entertainment company is about). As the project evolved functions were added, discarded or changed. Eventually parts of the system were accepted as a black box when the business planning manager realised that the (already operational) new data base contained all the data needed to feed his planning systems (Tabak 2007, pp 101-106). Ambiguity is not talked about, it is a component of stealth, even if unintended.

6. Actors as script translators: describing an existing system
The final case also involved the support of (hopefully) non-purposive behaviour, although in an academic context. Most readers of this paper will be all too familiar with the dilemmas of academic publishing and research (Steele 2006). The traditional system of academic publishing has been destabilised by a massive growth of universities worldwide, resulting in increasing government desire to control cost, quality and relevance of research, and by the advent of the internet, which has made academic papers cheaper to produce and much more easily accessible globally. This continuing study (Keenan and Cecez-Kecmanovic 2007) is investigating an institutional repository initiative at an Australian University. The researcher has previously done some work with the repository project; the research is based on published works of the advocates of repositories and open-access publication (Drott 2006), and on interviews with human actors who were chosen through the "snowballing technique", starting with the University Librarian and the project managers of the repository project (this is one way of "following the actors").

This case differs from those previously discussed in that there are some "external" actors who appear to set the context, some clear anti-programs (Latour 1992), and actors who appear to be quite sophisticated in their explicit understanding of the actor network in which they are involved. The "external actors" are the major academic publishers, university upper management, and governments who devise schemes to evaluate and fund university research. While this particular research takes these as "macro-actors", they are in fact quite actively lobbied by various individuals and institutions who appear as actors in this case study; much of this lobbying is informal, and actors are not always willing to be followed in this direction, making it very difficult to visualise a stable network. The anti-programs are promoted by the academic publishers who wish to profit from the ownership of copyright (and who are for reasons that are unclear at the forefront of the publishing industry in the move away from print), the learned societies, who are to some extent promoting disciplinary repositories, and governments and universities who are trying to limit measures of research performance. The actors are sophisticated because they are academics who have the time and training to contemplate these issues, who despite everything have managed to maintain some control over their own work, and who over the last three decades have experienced numerous examples of other actors attempting to conscript them to their networks.

The advantages of ANT in this case are that it encourages us to deconstruct common social phenomena such as "scholarly communities" and to shift scale from the global, where the success of any repository initiative depends on the enrolment of a high proportion of the world's respected academics, to the individual academic, who may translate the scripts of other actors in ways quite specific to their own situation. It may also (although this hasn't been done yet in this research) allow us to include more technically oriented concerns, such as the features of the repository software, the interests of its developers, its relationship with other software and hardware being used in universities, and the fact that in most cases the universities provide and control the computers on which the research is produced and accessed. The challenge for ANT is that in this case the various possible networks are more closely connected than usual, so that, in the Australian example, a change of government may place the very existence off some apparently key actors in doubt.

8. Varieties of ANT practice

The above examples give a sample of different ways of using ANT in IS research. To some IS researchers ANT seems an ideal way of theorising what is practised by business analysts, bringing together IS research and practice. There are still problems, however, in presenting ANT based research to practitioners because, although ANT method is close to IS practice, the underlying ontological and epistemological assumptions contradict the assumptions of most IS practitioners. Nevertheless, the experience of IS researchers could be carried across to broader business and management research to potentially bring research closer to practice.

These cases also throw some light on doing ANT. In all four cases observing the symmetries between success and failure and between humans and non-humans added considerably to our understanding of the projects. The encouragement to cross boundaries and move easily between different levels of detail worked well in the first three cases; these were projects within one company, where boundaries were more obvious and where actors were to reasonably well aware of the networks in action. In the final case success of the project within the one university is ultimately dependent on outcomes in several loosely linked global networks, so that crossing boundaries can easily lead to unmanageably complexity in the analysis.

ANT has much to offer researchers in IS and business and management in general. The richness of ANT means that there are still many unexplored pathways for ANT researchers and much remains to be discovered.

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