Network as Structure and Process in Information Systems Research: Contributions from Two Perspectives

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Abstract

The term "network" is commonly used in information systems research as a metaphor referring to relationships between people, organizational context and information technology. This paper reviews the contributions to information systems research from the perspectives of Social Network Analysis – where the network metaphor relates to structure, and Actor-Network Theory – where the network metaphor relates to process. Methodological implications of using each approach are identified and suggestions are made for integrating the two perspectives.

Keywords

IS Research; Actor-Network Theory; Social Network Analysis

INTRODUCTION

The term 'network' is widely used in everyday language as a metaphor for a wide range of interconnected entities, processes, events and people. So we freely talk of such things as the communications network, our social networks, the transport network, business-to-business networks and more. Furthermore, we use network as a verb to describe what we do- we not only network IT systems across functional and organisational boundaries, we also network with others to form possibly advantageous social relationships. It can be argued that our extensive use of the term 'network' (both the noun and verb) has been driven in part by the developments in information and communications technology that have transformed both business and social activity. We can work in virtual teams, communicate with our friends and colleagues electronically, and alter the structure of service provision, supply chains and even industries through the application of information and communications technology in sociotechnical networks. We take the ability to network and to create networks for granted – as a natural part of life in the 21st century.

Similarly in information systems research we often do not give a passing thought to the term network because the interconnectivity that it implies is fundamental to our understanding of the discipline. In this paper, the use of the network metaphor as basis for research in information systems is examined with reference to two approaches that are increasingly being used in IS research studies. Actor-Network Theory (ANT) and Social Network Analysis (SNA) have been used to examine, describe and explain a variety of information systems research issues. However, each approach is distinct in that they have emerged from different research traditions. In this paper, the contributions of each approach to IS research is examined and some suggestions for integrating these perspectives are made.

THE NETWORK METAPHOR IN INFORMATION SYSYTEMS RESEARCH

The network metaphor in information systems research can be traced to Kling and Scacchi's (1982) concept of "web models" which they proposed in response to research that focused on the explicit economic, physical or information processing features of information technology. Web models of computing explicitly take into account the social context surrounding computing technology and view information systems as "developed, operated and used by an interdependent *network* of producers and consumers…Their 'shape', the way they are used, the leverage they provide, and the interests they serve depend upon the interplay of stakeholders, resources, and social games within which they are deployed" (Kling 1987:309).

In a recent review of publications in *Information Systems Research*, Orlikowski and Iacono (2001) examined the extent to which the web model concept had been used and developed within the literature. In their analysis they identify five metacategories of how information technology is conceptualised within IS research studies. They categorise "web models" as contributing to one of these categories - the *ensemble* view of information technology. These studies treat IT as one element of a "package" of artifacts and social activity in which the focus is on "the dynamic interactions between people and technology" whether in the construction and deployment of information systems or in their use (Orlikowski and Iacono 2001:126).

Two distinct themes emerge from the ensemble perspective and each is based on a distinct network metaphor. The first is that of information systems development, innovation and implementation. The network metaphor in this view is *network as a process*. Systems of alliances (networks of relationships) between a variety of stakeholders are formed to construct and diffuse information systems. Information systems research that uses Actor Network Theory (ANT) takes this perspective. The second theme relates to system use and the influence of the social context. Information systems are embedded in networks of social relations that form a structure to constrain and enable system use. Here the metaphor is that of *network as structure*. Techniques from Social Network Analysis (SNA) are increasingly being used to examine the influence and relationship between structure and information systems. In the following sections, the contributions of these two theoretical perspectives are reviewed.

NETWORK AS STRUCTURE – SOCIAL NETWORK ANALYSIS

Social Network Analysis (SNA) is widely used in the social and behavioural sciences to map and analyse the structure of social networks. Social network analysis focuses on relationships among social entities and has been applied to a wide variety of research domains. For example; communications among members of a group, transactions between corporations, and treaties among nations (Wellman and Berkowitz 1988; Wasserman & Faust, 1994).

Social network analysis as it is practiced today has evolved from the intersection of a number of research traditions (Scott 1991). The approach is rooted in the structural concerns of anthropologist Radcliffe-Brown (1940) who saw that interaction patterns describing social structure can be viewed as a network of relations. The network metaphor for the concept of social structure later became increasingly popular with anthropologists and sociologists and specialist groups began to investigate ways of measuring the "texture" of these social networks. While some theoretical concepts with respect to social structure have emerged -eg "social capital" and "structural holes", a major contribution of SNA is through the development of sociometric measures based on graph theory that have emerged and been refined to act as a set of fundamental analytical concepts.

Network analysis is based on the measurement of interactions or relations between nodes. Depending on the level or focus of analysis, nodes may represent entities such as people, technology, groups, firms or even countries. Interactions and relations between nodes may be of several types: communication (information); instrumental exchange (money); power; sentiment (e.g. trust); roles (e.g. friendship). For empirical analysis, interactions and relations between nodes can be expressed in terms of the absence or presence of ties and represented in relational matrices. Once in matrix form, the data may be analysed in several ways through the use of matrix algebraic techniques. Social networks can also be represented as sociograms for visual analysis of network relations. The main forms of analysis undertaken in SNA relate to whether the study is concerned with how individuals in the network are clustered based on their patterns of relationships; or with the freedom or power of actors within the network to act (Zack 2000). Key measures and concepts used in network analysis include tie strength, network density, centrality, range, prominence and brokerage.

Network analysis and visualization are supported by an increasing number of software packages (eg UCINet, Netminer, Pajek). In addition, the development of improved graphical software packages has opened up the opportunity to be able to visualise social networks.

Social Network Analysis Information Systems Research

Social network concepts and analysis techniques have been applied to a range of issues involving information systems and information technology. The traditional application of SNA techniques in IS research have involved analyses of the relationship between the structure of networks and IS/IT. From this perspective, users and/or potential adopters of information systems are embedded in various formal and informal organizational networks. These relational structures both limit and enable people's access to resources. The nodes of the networks that form structure in such studies are usually individual people who are connected by way of affiliations with IT use or implementation, their role in the organization, or by their personal or task-related relationships with others. Therefore who one communicates with or who they go to for advice on system usage, their attitudes toward use of a new system etc. can be enabled or limited by their location in the network structure (Rice and Gattiker 2001).

With the proliferation of the Internet, an emerging application of SNA techniques has been to view computer networks as social networks (Wellman et al 1996). The simple premise here is that the linking of computers necessarily links people together forming a social network. Studies in virtual teams, virtual communities and teleworking can therefore benefit from taking this approach.

Some traditional and emerging themes of the use of social network analysis are outlined below and some example studies and associated literature are listed in table 1.

Influence of Network Structure on IT Adoption

Several studies have found that over time, users (particularly early adopters), increase their power and relational network centrality as they use new systems. For example Burkhardt & Brass (1990) used SNA to examine the organizational impacts of IT on the relationship between centrality, power and the timing of the adoption of a new distributed computing system. They found that early adopters increased their power and centrality to a greater degree than later adopters.

Influence of Network Structure on Attitudes to IT

The size of the social network and its diversity rather than how frequently members of the network communicated with one another were found to influence the rate at which employees learned to improve their performance through system use (Papa and Papa 1992). That is, it was the network structure rather than the activity that was more influential in changing attitudes. This is in line with Rice and Aydin (1991) who examined the mechanism by which individual attitudes toward an IS were influenced by the attitudes of socially proximate others. They found that attitudes towards an information system are socially influenced and that relational and positional proximity are greater influences than traditional occupational roles and spatial proximity. Similarly, Schmitz and Fulk (1991) found that the social influences of colleagues had pervasive effects on others' assessments of communications media.

Influence of IT Use on Organizational Structure

Zack and McKenney (1995) examined how existing social structure influences the way that an organization appropriates electronic messaging systems. They found that the computer-mediated communication (CMC) networks closely reflected social structure. Similarly, Spinardi, Graham and Williams (1996) found that the introduction of EDI consolidated and further embedded existing organizational relationships thereby preventing business process reengineering.

Structure of Online Communities and Computer-mediated Communication Media Use

Garton et al (1997) demonstrate the utility of the social network approach for studying computer-mediated communication in CSCW, virtual communities and in less bounded systems such as the Internet. Ahuja and Carley (1998) examined how virtual organizations that use email to communicate and coordinate their work found that for the case they describe, the virtual organization is similar to traditional organizations in that task-structure predicted perceived performance but dissimilar in that task structure did not predict objective performance. Haythornethwaite (2001) examined the types of relationships (work, information exchange, socializing, emotional support) that are supported by different kinds of media use (IRC, Webboard, email, telephone). Her results suggest that interpersonal tie strength is a strong determiner of the type and number of media used.

Information Systems Development and Project Management

While not explicitly using SNA, Sonnenwald (1995) developed models of IS development team collaborations to examine how intergroup communication networks evolve throughout the design process. Sawyer (2000) compares the use of network analysis techniques for understanding the software development process to linear and group models. Using this approach implies that the individual members of software development teams, and the social ties that connect them, define the software development effort.

Mead (2001) used SNA techniques to examine the use of a web-based project management system to support communications among project team members.

Knowledge Mapping and Visualization

Kanfer et al (2000) propose that SNA can be used at multiple levels of analysis to examine the mobility of knowledge across distributed alliances. Cross et al (2001) use SNA techniques as a basis for identifying barriers and conduits to knowledge in formal and informal organizational social networks. Similarly, Stein (1992) used SNA techniques to identify and map sources of expertise within formal and informal social networks. Wasko and Teigland (2002) investigate networks of practice to examine patterns that contribute to the good of the community. Their analysis uses SNA techniques to visualize the network and find that it is star-shaped.

Author	Object of Study
Rice & Aydin (1991)	User attitudes to new IS implementation
Sonnenwald (1995)	Communication among system design team members
Hinds & Kiesler (1995)	Influence of structure on IT use
Wellman, Salaff et al (1996)	CSCW, Telework, Virtual Communities
Ahuja & Carley (1998)	Virtual Organisations; Email communication networks
Haythornthwaite (2001)	Collaborative work environments
Zack & McKenney (1995)	Social influences on group electronic media use
Barley (1990)	Technology/structure relationship
Schmitz & Fulk (1991)	Social influences on electronic media use
Butler (2001)	Online Communities
Mead (2001)	IS project Management
Nardi et al (2002)	Visualisation of personal social networks
Kanfer, Haythornthwaite et al (2000)	Knowledge mobility
Sawyer (2000)	Software development teams
Hislop, et al (2000)	Knowledge networks in ERP implementation

Table 1 – Example Applications of Social Network Analyses in IS Research

Author	Object of Study
Bloomfield et al (1992)	Role of IS in mediating and reinforcing changes in organizational practice and discourse
Lea, O'Shea & Fung (1995)	Relationship between content and context in CMC design and implementation
Vidgen & McMaster (1996)	IS development stakeholder interest influence on design
Monteiro & Hanseth (1996)	Relationship between information infrastructure and new organizational forms
Brigham & Corbett (1997)	Relationship between IT, organisational power relations and knowledge during implementation
Hanseth & Braa (1998)	ERP (SAP) as infrastructure
Walsham & Sahay (1999)	GIS implementation
Doolin (1999)	EIS project failure
Fomin & Keil (2000)	Standards in Telecommunications
Atkinson (2000)	IS Development methodology
Lowe (2000)	IS Implementation in healthcare
Sidorva & Sarker (2000)	BPR failure
Monarch & Levine (2000)	Knowledge networks
Allen (2002)	PDA evolution
Klischiewski (2000)	IS development

Table 2 – Example Applications of Actor-Network Theory Concepts in IS Research

The use of the network metaphor throughout these studies is in terms of (relatively) static structures. Social Network Analysis provides techniques for identifying, mapping and measuring these structures.

NETWORK AS PROCESS – ACTOR –NETWORK THEORY

Actor Network Theory originated and has evolved in the study of the sociology of science (Latour, 1987; Law, 1991). It is closely aligned with a social construction of technology perspective (Bijker et al 1987) in which the development of technology is viewed not just as a technical product of design, or entirely shaped by social factors. Rather technology is grounded in and constituted by social forces and open to more than one interpretation (i.e. exhibits interpretive flexibility). The goal of social constructionism is to trace how over time, different groups or individuals create a "closure" as technology comes to assume one particular form from a range of possible alternative interpretations. That is, how the interaction of social groups chooses to make important design decisions and take a particular design trajectory to the point of implementation. ANT extends this perspective and argues that social groups themselves are constructed in part by the technology. The process involves not only the construction of the technology but also the users – both technology and social groups

mutually elaborate each other in a reflexive process (Lea et al. 1995). That is, through their interactions with one another and the technology itself, social groups are also continuously constructed. ANT is therefore concerned with studying the mechanics of power relations as this occurs through the construction and maintenance of networks made up of both human and non-human actors.

In this paper, it has been suggested that ANT is a process view of a network. However, the word "network" has been identified Latour (1998) as one of the "nails in the coffin" of ANT. He expresses regret at using a technical metaphor that is perceived as a means of transport without influence over what is being transported – an instantaneous, unmediated access to information. This is not how he and his colleagues meant the term to be used. Rather, it was intended that the "network" in ANT referred to a "series of transformations – translations, transductions" (Latour 1998:xxx). Under ANT, relationships between actors do influence one another. Hence, the actor-network is dynamic – it is a process rather than a structure and continually changing.

The ANT perspective is derived from the belief that human actors "inscribe" their interests into technological artifacts through the transformation and funnelling of interests in a desired direction. The utility of ANT in researching information systems derives from applying it as both theory and methodology to trace through how the various interests of actors are (or are not) translated into a relatively stable network (Walsham 1998).

One of the principle tenets of ANT is that technology systems should be viewed as actors in a network in the same way that humans are. This point is controversial and has attracted much criticism and debate (Collins and Yearley 1992). However, the proponents of ANT suggest that allowing artifacts the same explanatory status as human actors is "an analytical stance, not an ethical position" (Law 1992:383). What this position encourages is the detailed description of the mechanisms that bind the network together, without being concerned with how this has been achieved. Monterio (2000) suggests that the actor network should be viewed as the context. It is those elements in a context that shape action. So in customer relationship management, the actor-network includes contracts that are inscribed with management commitments, existing modules and systems, hierarchical power structures and more.

While the style of much of the ANT literature can be initially difficult to fathom, IS researchers have been attracted to it because it provides terminology and a language for describing the process of network formation. An actor-network is seen as a heterogeneous network of aligned interests. The alignment of interests can be traced through four major stages: problematization – in which one or more actants identifies a situation as problematic and can persuade others to join in tackling it; interessement – which is a process whereby the involved actors strengthen their resolve to move the problem in a chosen direction by silencing opponents and/or entering into alliances with other networks; enrolment – whereby humans and non-humans are persuaded that it is in their best interests to join the network; and mobilization in which the emergent actor-network addresses the initial problem (Callon 1986). It is the concepts such as enrollment, inscription, translation, and irreversibility together with the fundamental concept of the actor-network that provide IS researchers with a language for interpreting the processes of network formation.

Actor Network Theory and Information Systems Research

In relation to information systems research there are several articles that call for the use of ANT as an interpretive device but few actually make full use of it as a methodology. Frequently it is the ANT language that is used for interpretive purposes rather than an actual empirical tracing of actor-networks. Some major themes to which ANT concepts have been applied are outlined below and further references summarized in Table 2.

Analyses of Information Infrastructure

Several cases of information infrastructure and development are presented in terms of ANT in Ciborra (2000). Here information infrastructure is defined as "an evolving shared, open, and heterogeneous installed base" (Hanseth 2000:60). Monterio and Hanseth's (1998) examination of the process of the development of standards for EDI is indicative of these studies. Hanseth and Braa (1998) examine the installation and integration of SAP into the wider corporate infrastructure.

Analyses of the Systems Development Process

Bloomfield et al (1992) analyse the development of resource management information systems in UK hospitals. Using ANT analyses of data collected over a three year period, they reveal the a considerable level of interpretive flexibility surrounding how stakeholders understand the nature and purpose the systems as well as the technology used to implement it. Lea et al (1995) trace the development of a CMC system for integrating a networked organization over a four year period. Vidgen and McMaster (1996) traced stakeholder interests throughout the development of a car-parking system and demonstrate how interests become inscribed in the system. Klischewski (2000) describes the development of a modularized learning system as a series of network transformations.

Atkinson uses ANT concepts to describe how a soft systems based methodology (SiSTEM) facilitates problem solving in networks.

Analyses of IT Innovation

Several authors have suggested that ANT provides a richer description of innovation than can be achieved with traditional diffusion of innovation (eg Tatnall and Gilding 1999). Graham (1998) examined the innovation of electronic communications networks in a livestock auction market. He uses ANT terminology to conclude that complexity and barriers to network building led the networks to be constructed from existing components and social linkages – limiting the potential of the innovation to incorporate radical change.

Harrison and Laberge (2002) explore the process of diffusion of an innovation that involved both the use of IT to remodel a production process and the introduction of teamwork to restructure the organization of work. Using ANT they demonstrate how a chain of arguments were constructed to justify steps in the constitution of the innovation.

Knowledge Management

Although not directly related to IS research, studies in the area of knowledge management are relevant to the design and development of information systems. Hull (1999) in noting the inadequacies of the Knowledge Management literature, proposes that ANT is a suitable and useful method for investigating knowledge management practices. Fox (2000) uses ANT to critique the theory of communities of practice. The contribution that he sees for ANT is in term of enriching understanding of organizational learning (and therefore information systems that promote and support it). Monarch and Levine (2000) examine actor-networks in which scientific and engineering knowledge is established with the objective of evaluating knowledge management methodologies and tools.

The common theme addressed in ANT based studies is the use of network as a process. ANT provides a language to describe these processes under consideration.

DISCUSSION

Both SNA and ANT use a network metaphor albeit from different perspectives. Each perspective has particular strengths and have made contributions to the information systems discipline. As noted by Lea et al (1995), ANT has little in common with traditional structural analyses of social network structure (eg Rice & Aydin 1991). They see the problem with traditional approaches to the study of social structure and technology as making strong distinctions between the (technical) content of technology and the social (context) into which it is introduced. However, there have been some recent proposals for combining concepts from each approach in the studying information systems (eg, Lamb et al 2000). The following discussion compares and contrasts the network metaphor underlying each approach with a view to integrating their strengths.

Both SNA and ANT focus on the microsocial processes of organizational life. The traditional microsocial view of the relationship between technology and structure argues that new technologies first alter tasks and skills and that these changes create, in turn, opportunities and pressures for modifying organizational structure (Barley 1990). Through its focus on the interaction and ties between actors, SNA can provide empirical measurement of the characteristics of the "structure" that emerges from the concrete activities and interactions that characterise use of information systems or involvement in their development and management. The measureable "structure" is thus a social network inscribed by actions and interactions. Walsham (1997) suggests that ANT should be used in conjunction with structuration theory to address the broader social structures that influence the microsocial interactions.

SNA and ANT both offer methodological guidance in the conduct of research. Most studies of IT using SNA adopt a positivist position. Hypotheses are developed, network samples or populations are considered, data is collected in a (semi-) structured fashion and appropriate analytical techniques are applied. However, as Wellman (2002) demonstrates, this is not to say that SNA cannot be used as part of wider ethnographic studies. ANT however is almost exclusively used in interpretive analyses, providing a language for tracing actors and empirically describing network formation. Lee & Hassard (1999) suggest that ANT appears to be ontologically relativist in that we can perceive the world to be organized differently, but they see ANT as empirically realist in providing "theory laden" descriptions. They view this as a strength in organizational studies. Despite ontological differences, the careful integration of SNA techniques within an actor-network theoretic framework, may strengthen or at least complement interpretation and description.

Why Process Needs Structure

Using ANT as a method requires us to follow the actors and to investigate and document network elements, both human and non-human, the processes of translation and inscription, the creation of black-boxes and the degree

of stability of networks (Walsham 1997). Such an approach puts the focus firmly on the dominant interests that are being inscribed in the network. It does not however help with examining the alternatives. What other actants and alternative interests have been sidelined in the formation of the actor-network? Other actants (and inscribed interests) may have encountered significant structural barriers to participation in the actor-network. By performing structural analyses of network participants it may be possible to examine why one design emerged rather than another, as well as understanding the impact of the emerged actor-network on the interests of others who are sidelined.

Analysis of network structure may also help with understanding how an actor-network becomes 'black-boxed'. This is the point at which the actor-network achieves stability. This may be affected by relations of power and dependency among actants. Structural analysis through SNA may provide insight regarding why some actors chose to accept (or reject) the actor-network.

Why Structure Needs Process

Analyses of information technology that solely use a social network approach and focus on structure treat context as being static and stable. SNA-based analysis fails to examine the complex interaction between context and action as (the IT embedded in) the social network evolves over time (Lea et al 1995). So for example examining whether the use of a new IT system is influenced by an individual's position in a social network tells us nothing of why or how that social structure has emerged. The structural approach commonly perceives context as a backdrop for the implementation of technology and as such context is separated from individual interaction. An actor-network approach adopts the perspective that the boundary between content and context is continually negotiated and re-negotiated by the actors in the course of systems development and use. The concept of a heterogeneous actor-network as representing context can sensitise how the structural analysis of SNA are interpreted.

CONCLUSION

The relationships between system users, the technology and organizational context are central to IS research endeavours. As information and communication technology have enabled greater connectivity between people, systems and organizations, the concept of information systems as sociotechnical networks has grown in significance. To return to Orlikowski and Iacono's (2001) call to better conceptualise IT in Information Systems research, they make several points regarding IT artifacts that they propose should be considered in the design of IS research. Central to their argument are two premises. Firstly, that IT artifacts are always embedded in some time, place, discourse and community practices (that is that they exist within networks of social relations that form a structure). Secondly, that IT artifacts made up of fragmented parts that are not static and unchanging but emerge from ongoing social and economic activity (that is they emerge over time from a network of events, interactions and activities). Actor Network Theory (ANT) with its focus on the network process which shapes IT design, innovation and use and Social Network Analysis (SNA) with a focus on the network structures within which systems are embedded, have advanced IS research.

This paper has examined the conceptual traditions of each of these approaches and the areas of IS research to which each has been applied. ANT has its roots in the sociology of science, whereas SNA is grounded in the theory and analysis of social structure. Despite these differences, this paper suggests that an integration of both the network as process and network as structure perspectives can provide a framework for investigating the relationship between IT and context. Although further research is required it has been suggested in this paper that it is possible to use the analytical techniques provided by both SNA and ANT in a complementary manner.

REFERENCES

Ahuja, Manju K., Galletta, Dennis F. and Carley, Kathleen M. (2003) Individual Centrality and Performance in Virtual R & D Groups. *Management Science.* Vol 49, No. 1:21-38.

Ahuja, Manju K. & Carley, Kathleen M. (1998) "Network Structure in Virtual Organizations". *Journal of Computer Mediated Communication*, Vol 3, issue 4.

Allen, J.P. (2002) "Where Enrollment Meets Structure: Understanding PDA Evolution Through Sociotechnological Theory". *Proceedings of the 8th Americas Conference on Information Systems,*pp1791-1797.

Atkinson, C.J. (2000) "The 'Soft Information Systems and Technologies Methodology' (SISTeM): An Actor Network Contingency Approach to Integrated Development." *European Journal of Information Systems. Vol 9, pp104-123.*

Barley, Stephen R. (1990) "The Alignment of Technology and Structure through Roles and Networks". *Administrative Science Quarterly,* Vol. 35, Issue 1, pp61-96.

Bijker,W.E., Hughes, T.P. & Pinch, T. (eds). (1987) *The Social Construction of Technological Systems.* MIT Press, Cambridge, Mass.

Bloomfield, B.P., Coombs, R., Cooper, D.J. & Rea, D. (1992) "Machines and Manouevres: Responsibility Accounting and the Construction of Hospital Information Systems." *Accounting, Management and Information Technology*, *Vol 2, No. 4:*pp197-219.

Brigham, Martin & Corbett, J. Martin (1997) "E-mail, Power and the Constitution of Organisational Reality" *New Technology, Work and Employment,* Vol 12, issue 1, pp 25-35.

Burkhardt, M.E. and Brass, D.J. (1990) "Changing Patterns of Patterns of Change:The Effects of a Change in Technology on Social Network Structure and Power" *Administrative Science Quarterly,* 35, 104-127

Butler, Brian S. (2001) "Membership Size, Communication Activity, and Sustainability: A Resource Based Model of Online Social Structures". *Information Systems Research. Vol 12, No. 4, pp.346-362.*

Callon, M. (1986) "The Sociology of an Actor-Network" *in* Callon, M., Law, J. & Rip, A. (eds). *Mapping the Dynamics of Science and Technology*.MacMillan, London.

Collins, H.M. & Yearley, S. (1992) "Epistemological Chicken" *in* Pickering, A. (ed.) *Science as Practice and Culture.* Chicago University Press, Chicago.

Ciborra, C.U. (2000) *From Control to Drift: The Dynamics of Corporate Information Infrastructures.* Oxford University Press, Oxford.

Cross, R., Parker, A., Prusak, L., and Borgatti, S.P. (2001) "Supporting Knowledge Creation and Sharing in Social Networks". Organizational Dynamics, Vol. 30, No. 2, pp. 100-120.

Doolin, Bill (1999) "Sociotechnical Networks and Information Management in Health Care" *Accounting, Management and Information Technologies, Vol 9:95-114.*

Fomin, Vladislav & Keil, Thomas (2000) "Standardization: Bridging the Gap Between Economic and Social Theory" *Proceedings of the 21st International Conference on Information Systems,* Brisbane, Australia

Fox, Stephen (2000) "Communities of Practice, Foucault and Actor-Network Theory". *Journal of Management Studies, Vol 37, No. 6.*

Graham, Ian (1998) The Construction of a Network Technology: Electronic Livestock Auction Markets. *International Journal of Innovation Management.* Vol. 2, No. 2:183-199.

Harrison, Denis and Laberge, Murielle (2002) Innovation, Identities and Resistance: The Social Construction of a Social Network. *Journal of Management Studies*, 39(4):497-521.

Hanseth, O. (2000) The Economics of Standards *in* Ciborra, C.U. ed. *From Control to Drift:The Dynamics of Corporate Information Infrastructures*. Oxford University Press, London, pp56-70.

Hislop, D., Newell, S., Scarborough, H. & Swan, J. (2000) "Networks, Knowledge and Power: Decision Making, politics and the Process of Innovation". *Technology Analysis and Strategic Management, Vol 12, No.3.*

Hinds, P and Keisler, S. (1995) "Communication Across Boundaries: Work, Structure, and Use of Communication Technologies in a Large Organization" *Organization Science, Vol 6, No. 4* :373-393.

Hull, Richard (1999) "Actor Network and Conduct: The Discipline and Practices of Knowledge Management". *Organization,6(3)*:405-428.

Kanfer, Alaina G., Haythornthwaite, Caroline, Bruce, Bertram B, Bowker, Geoffrey et al (2000) "Modeling Distributed Knowledge Processes in Next Generation Multidisciplinary Alliances". *Information Systems Frontiers.vol2, issue 3/4 , pp317-331.*

Kling, R. (1987) "Defining the Boundaries of Computing Across Complex Organizations" *in* Boland, R. and Hirschheim, eds. *Critical Issues in Information Systems Research*. John Wiley & Sons, New York, 307-362.

Kling, R. and Scacchi, W. (1982) "The Web of Computing: Computer Technology as Social Organization" *Advances in Computers,* Vol 21:

Latour, B. (1987) *Science in Action.* Open University Press, Milton Keynes.

Latour, B. (1998) “On Recalling ANT” *in* Law, J and Hassard, J. eds. *Actor Network Theory and After*, Blackwell, London

Lamb, R., Sawyer, S. & Kling, R (2000) “A Social Informatics Perspective on Socio-Technical Networks” *Proceedings of the 6th Americas Conference on Information Systsems,* Long Beach, C.alifornia

Lamb, R. (2001) “Tracing Influence through Intranets of Compliance” *Proceedings of the 34th Hawaii International Conference on System Sciences.*

Law, J. (ed). (1991) *A Sociology of Monsters: Essays on Power, Technology and Domination.* Routledge, London.

Lee, Nick and Hassard, John (1999) “Organization Unbound: Actor Network Theory, Research Strategy and Institutional Flexibility” *Organization*, Vol 6 (3):391-404.

Lea, Martin, O’Shea, Tim & Fung, Pat (1995) “Constructing the Networked Organization: Content and Context in the Development of Electronic Communications” *Organization Science, Vol. 6, No. 4, pp.462-478.*

Lowe, Alan (2000) “Accounting Information Systems as Knowledge Objects: Some Effects of Objectualization.” *Management Accounting Research. Vol 12, pp. 75-100.*

Mead, Stephen (2001) “Using Social Network Analysis to Visualise Project Teams” *Project Management Journal, Vol. 32, No. 4:32-38.*

Monarch and Levine (2000) “Knowledge Networks: A Case Study in Establishing a Domain of Software Engineering Knowledge” *Proceedings of the 6th Americas Conference on Information Systems*, Long Beach, California.pp 1681-1687

Monterio, Eric (2000) “Actor-Network Theory and Information Infrastructure” *in* Ciborra, C.U. *From Control to Drift: The Dynamics of Corporate Information Infrastructures* .Oxford University Press, Oxford.

Nardi, Bonnie A., Whittaker, Steve, Isaacs, Ellen, Creech, Mike, Johnson, Jeff, Hainsworth, John (2002) “Integrating Communication and Information through ContactMap. *Communications of the ACM.* Vol 45, No. 4:89-95.

Orlikowski, Wanda, J. and Iacono, C. Suzanne (2001) “Research Commentary: Desperately Seeking the “IT” in IT Research – A Call to Theorizing the IT Artifact”. *Information Systems Research,* Vol 12, No. 2, pp121-134.

Orlikowski, Wanda J. & Barley, Stephen R. (2001) “Technology and Institutions: What Can Research on Information Technology and Research on Organisazations Learn From each Other?” *MIS Quarterly,* Vol 25, No. 2, pp. 145-165.

Papa, W. and Papa, M. (1992) “Communication Network Patterns and the Re-invention of New Technology”. *Journal of Business Communication,* 29(1):41-61.

Rice, R. and Gattiker, U (2001) “New Media and Organizational Structuring” *in* Jablin,F.M. & Putnam, L. *The New Handbook of Organizational Communication*, Sage Publications, Thousand Oaks:544-581.

Rice, R. & Aydin (1991) “Attitudes Toward New Organizational Technology: Network Proximity as a Mechanism for Social Information Processing.” *Administrative Science Quarterly. Vol. 36:*219-244.

Sawyer (2000) "A Social Analysis of Software Development Teams: Three Models and their Differences" *Proceedings of the .. AMCIS,* Long Beach, California:1645-1649.

Scott, J. (1991) *Social Network Analysis:A Handbook*. Sage Publications, Great Britain.

Schmitz, Joseph and Fulk, Janet (1991) “Organizational Colleagues, Media Richness, and Electronic Mail: A Test of the Social Influence Model of Technology Use. *Communication Research, Vol. 18, No.4:487-523.*

Sidorova, A. & Sarker, S (2000) “Unearthing Some Causes of BPR Failure: An Actor-Network Theory Perspective” *Proceedings of the 6th Americas Conference on Information Systems,* Long Beach, California.

Sonnenwald, Diane H. (1995) “Contested Collaboration: A Descriptive Model of Intergroup Communication in Information System Design” *Information Processing and Management. Vol 31, No. 6, pp859-877.*

Spinardi, G, Graham, I., & Williams, R. (1996) “EDI and Business Network Redesign: Why the Two Don’t Go Together.” *New Technology, Work and Employment, 11:*16-27.

Stein, Eric W. (1992) "A Method to Identify Candidates for Knowledge Acquisition" *Journal of Management Information Systems. Vol 9,No. 2, pp161-172.*

Rice, Ronald E. & Aydin, Carolyn (1991) "Attitudes Toward New Organizational Technology: Network Proximity as a Mechanism for Social Information Processing" *Administrative Science Quarterly.36:219-244.*

Tatnall, A. and Gilding, A. (1999) "Actor-Network Theory and Information Systems Research." *Proceedings of 10th Australasian Conference on Information Systems (ACIS),* Wellington, Victoria University of Wellington.

Vidgen, R. & McMaster, T. (1996) "Black Boxes, non-human stakeholders and the translation of IT through mediation". *In* Orlikowski, W.J., Walsham, G., Jones, M.R., DeGross, J.I. (eds.) *Information Technology and Changes in Organizational Work.* Chapman-Hall, Cornwall. 250-271.

Wasserman, S. & Faust, K. (1994) *Social Network Analysis: Methods and Applications*. Cambridge University Press, Cambridge.

Walsham, G. (1997) "Actor-Network Theory and IS Research: Current Status and Future Prospects" *in* Lee, A.S., Liebenau, J., & DeGross, J. (eds.) *Information Systems and Qualitative Research*. Chapman-Hall, London, 466-480.

Walsham, Geoff & Sahay, Sundeep (1999) "GIS for District-Level Administration In India: Problems and Opportunities" *MIS Quarterly, Vol 23, Issue , pp. 39-67.*

Wellman, B. & Haythornethwaite, C. (2002) *The Internet in Everyday Life.* Blackwell Publishing, Malden, MA, USA..

Wellman, B. & Berkowitz, S.D. (1988) *Social Structures*. Cambridge University Press, Cambridge.

Wellman, Barry, Salaff, Janet, Dimitrova, Dimitrina, Garton, Laura, Gulia, Laura, Haythornethwaite, Caroline (1996) "Computer Networks as Social Networks: Collaborative Work, Telework and Virtual Community. *Annual Review of Sociology. 22:213-238.*

Wellman, Barry, Salaff, Janet, Dimitrova, Dimitrina, Garton, Laura, Gulia, Milena, Haythornthwaite, Caroline (1996) "Computer Networks as Social Networks: Collaborative Work, Telework, and Virtual Community". *Annual Review of Sociaology.* Vol 22:213-238

Zack, Michael H. & McKenney, James L. (1995) "Social Context and Interaction in Ongoing Computer-Supported Management Groups" *Organization Science.* Vol 6, No. 4:394-422.

Zack, Michael (2000) "Researching Organizational Systems Using Social Network Analysis". *Proceedings of the 33rd Hawai'i International Conference on System Sciences, Maui, Hawai'i, January, 2000.*

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