Chapter I

Web-Based Education Accountability System and Organisational Changes: An Actor-Network Approach

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Abstract

The learning and accountability needs in a teacher education department drove the development of a novel Web-based education accountability system (EAS). To fit the EAS with the organization, actor-network theory (ANT) was used to guide the social and technological development. In the course of fitting the technology to the educational setting, a novel multi-dimensional perspective to ANT was formalized. Four dimensions of organizational culture, politics, process, and profession were used. Participant observation, field notes, and interviews were used to reveal how standard teacher education practices were created and recreated. Detailed translations occurring at multiple levels provided insight into the technical agency of the EAS and showed technology shaped the emergence of a socio-technical solution for a teacher education program.

Introduction

This chapter considers the introduction of a new 'educational accountability' technology in a teacher education program. The interactions between the technology and the educational organization are explored. Contributions of the chapter include the method of developing the technology and observations about how an educational organization can best exploit its technology.

Educational accountability is critical to successful education. A search on the Educational Resource Information Center (ERIC) citation database in May 2007 for citations containing the term 'accountability' returned 18,000 citations. Multiple books on the subject of education accountability were published in 2007, including Wilkerson and Lang (2007) and Drake (2007). Many of the ERIC citations are related to teacher accountability and the use of information systems to support accountability.

Teacher education accreditation has presented great challenges to teacher education programs in the United States. The introduction of new standards by the National Council for Accreditation of Teacher Education (NCATE) has accentuated these challenges (Castenell, Benson, deMarrais, Butchart, & Lewis, 2001; Linn, 2000). The comprehensive data collection mandated by the NCATE 2000 standards require advanced IS solutions and organizational changes (Wise, 2001).

To better understand the interplay between technology and organizations, the "black-box" of technology and process must be opened to expose the embedded socio-economic patterns (Bijker & Law, 1992). The implementation of an information system (IS) is shaped by the organizational context and simultaneously shapes the organization (Orlikowski, 1991). Economic, political, and cultural issues should be examined together with the IS as a "web of computing" or "socio-technical interaction network" (Kling, Kim, & King, 2003). Common approaches to researching technological innovation in education focus on the technical aspects of an innovation, and cannot account for the interactions between IS design and organizational changes (Scacchi, 2004; Orlikowski & Iacono, 2001). *actor-network theory* (ANT) treats equally the contributions of both human and non-human actors, and can capture the complex interactions between humans and technology.

The notion of actors and networks is fundamental to understanding how information systems diffuse in educational organizations (Lewis, Marginson, & Snyder, 2005). The actor-network approach has been used to interpret the relationship between existing technology and education (Morgan & Ryan, 2003). This chapter looks at both the development and the use of an information system in education with the help of ANT; the education application is teacher education accreditation.

This study extends ANT analysis with multi-dimensional views to examine the successful implementation of a Web-based education accountability system (EAS). The

EAS was implemented in a teacher preparation unit (hereafter called the 'unit') in a Department of Education at the University of Maryland, Baltimore County. The EAS was used to help the teacher candidates to learn and the unit to teach. The impact of Web technology on learning (e.g., Esnault & Zeiliger, 2000; Folkman & Berge, 2002) has been extended in this study to overall program improvement.

Theoretical Framework

Technological determinist approaches to technology innovation contend that only the 'most appropriate' innovations are adopted, and assume that all outcomes of technological change are attributable to the technological rather than the social (Grint & Woolgar, 1997). At the other extreme is social determinism, which holds that social factors can be used to explain technological change (Law & Callon, 1988) and concentrates on the investigation of social interactions, attributing little to technology. Intermediate approaches emphasize the *contingent relationship* between the social and technical: social context enables and constrains the usage of a technology, while technology conditions the social context (Barley, 1986; Giddens, 1984; Kling, 1987; Orlikowski, 1992). One approach that strikes a balance between the social and technical elements is ANT (Doolin & Lowe, 2002; Neyland, 2006). In terms of the adoption of technology in education, ANT stands in sharp contrast to diffusion theory (Rogers, 2003). Diffusion theory in education treats technology as immutable (Dooley, 1999), while ANT assumes that technology and social context shape one another.

ANT treats human and non-human stakeholders as actors who have interests in a socio-technical actor-network. The actor-network seeks stabilization through the processes of translation and inscription. The interests of various actors are translated, aligned, and inscribed into technical and social arrangements, such as business norms or software applications, which stabilize the actor-network, at least temporarily (Callon, 1987). Once stabilized, an actor-network may become seemingly irreversible and thus resistant to further translation (Callon, 1991). Therefore, formation and maintenance of a strong actor-network with aligned interests is crucial to the success of an IS project.

Multiple perspectives are valuable for IS development (Hirschheim & Klein, 1989). *Multi-dimensional analysis* has its root in 'multiple perspectives' theory (Steinbruner, 1974; Checkland, 1981). Examples of multi-perspective theory include: Technology-Organization-People (Linstone, 1999), Wuli-Shili-Renli (Zhu, 2000), and Multi-Modal Systems Design (de Raadt, 2001). Atkinson's multidimensional representation of actor networks identifies four dimensions: the informational, the clinical decision making, the psychosocial, and the political (Atkinson, 2002). However, Atkinson did not explicitly advocate a multi-dimensional analysis.

In this study, dimensions at a macro and a micro level are identified from a taxonomy of IS success factors (Larsen, 2003):

- **Macro level:** (1) Organizational culture; (2) Power relationship and politics;
- **Micro level:** (3) Process and operation; (4) Professional.

These four dimensions are most relevant to teacher education program improvement and accreditation.

Actor-networks representing multiple alignment themes can be broken into several actor-networks (see Figure 1), and each could be called a one-dimensional actor-network (ODAN). The same actor can be involved in different ODANs. Three models (de Vreede, van Eijck, & Sol, 1996) are adapted to illustrate the ODANs: ***a***ctor model, ***p***rocess model, and ***i***nteraction model (API).

The *interaction model* consists of actors communicating with each other by sending messages, or constraining each other, such as controlling resources. The symbols used for the graphical representation of an interaction model are given in Figure 2. An example shows a distance education system (DES) used for an online master's degree program (see Figure 3). The interaction model also identifies actors in the actor-network. Actors are identified by following the interacting activities of the DES. The DES was constrained by the budget, the academic requirement, the developer,

Figure 1. Convert an actor-network (left) into multi-dimensional actor-networks (right)

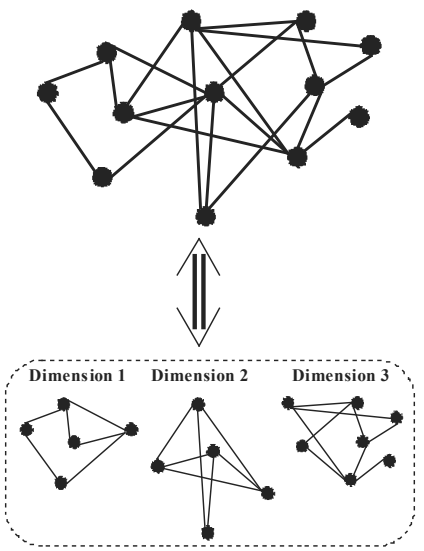


Figure 2. Symbols of the interaction model

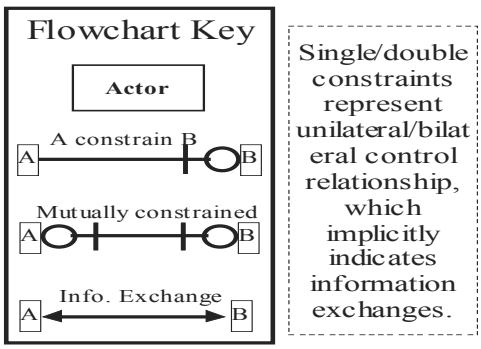
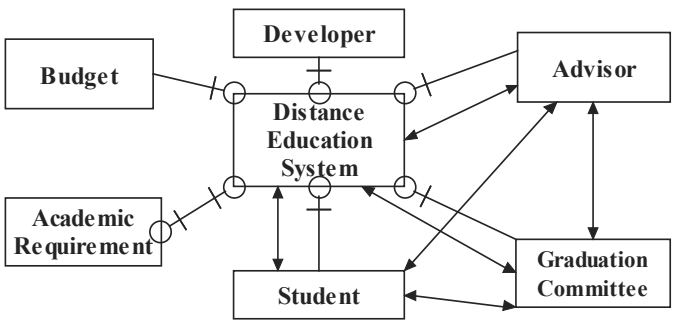


Figure 3. Example of an interaction model



and the users. The users' activity would affect the functions and purposes of the DES. In Figure 3, the DES and the academic requirement are mutually constrained. The emergent features of the DES and the academic requirement are changed and shaped interactively via translations and negotiations.

The interaction model does not describe how the actor-network was formed and aligned for a certain goal. The *process model* bridges the gap by modeling a sequence of actions along the actor-network alignment process. The process model shows how the various stakeholders use the DES to maintain the online academic programs.

The third and final model is the *actor model,* which depicts the interdependencies of the actions an individual actor has to perform to achieve actor-network stability. An actor model consists of the same elements as a process model. The difference is that the actor model represents all the actions of individual actors, whereas the process model represents the actions of all actors in an actor-network. model symbols are pictured in Figure 4, and an actor model is illustrated in Figure 5. The actor model shows how the students are enrolled, taught, and administered via the DES. The workflow is useful to reveal the details of each process.

Figure 4. Symbols of the actor model

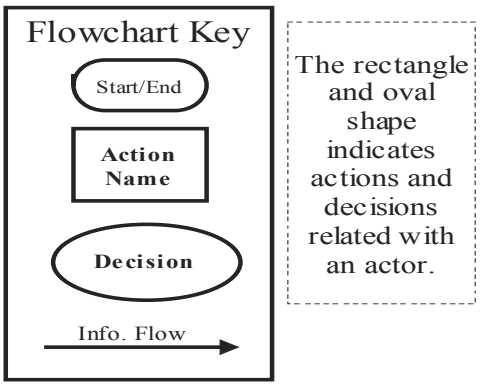
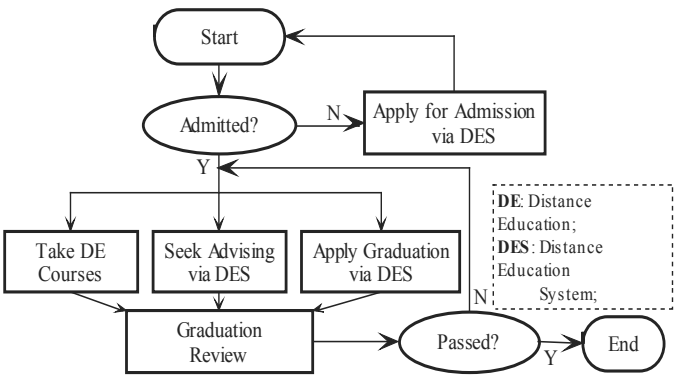


Figure 5. Example of an actor model



Case Study

The selection of this case is based on two issues. The first is that the unit (Department of Education, University of Maryland, Baltimore County) is undergoing dramatic organizational changes. Technology and social agendas are ill-defined because there is no best practice to follow. Secondly, academic departments are different from for-profit firms in that they are more autonomous and have fewer profit-making pressures. The Maryland Redesign of Teacher Education (Redesign) sets the context for the implementation of a comprehensive assessment system in the unit. To meet the teacher standards from the state, federal, and professional organizations, the unit built the *education accountability system*. ANT is used to analyze how the EAS and organizational changes are mutually shaped and constructed during and after the IS development.

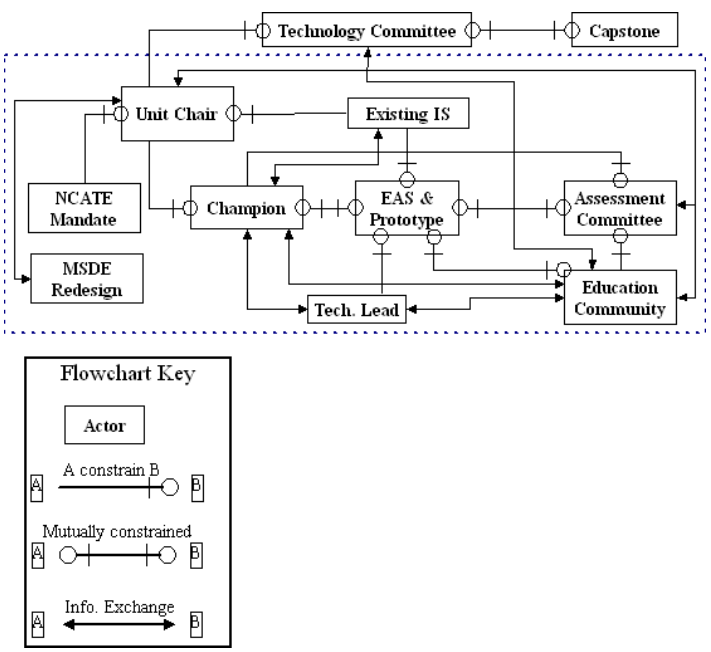
Data were collected from both primary and secondary sources. Primary data sources were the *interviews*. Secondary sources were publications, documents, and annual

reports of the unit. Secondary data cover different sources and provide an essential preparation and guidance for the interviews. The interviewees were selected on the basis of their closeness to the topics of the study and their levels of experience in management and organizational issues. Five faculty, four supervisors, six teacher candidates, and three administrators were interviewed. Each interview ranged from one to one-and-a-half hours. All interviews were digitally recorded and transcribed into 'Word' format.

Organizational Culture

Organization history, norms, leadership, and environment were identified as the actors to initiate the EAS project. As shown in an interaction model (see Figure 6), the inefficiency of the existing IS challenges the unit chair. Informed by the Redesign, the unit chair expected changes to meet these challenges. The Capstone and the EAS were two competing alternatives. The champion of the EAS employed specific strategies to enroll the identified actors (chair, technology lead, existing IS, and education community), while the technology committee failed to do so. The champion portrayed the EAS as an indispensable technology and established herself as the obligatory passage point (OPP) through which other actors could access the

Figure 6. Interaction model: Organizational culture. The actors inside the dotted rectangle represent the final aligned actor-network.



EAS. The champion defined the roles of other actors to play in the actor-network.

The technology lead was persuaded by the superiority of the EAS over Capstone and inscribed the proposal into a prototype system, which itself became an actant and spoke for the champion in many contexts. Additionally, the advocate of the Capstone did not form any connections with other actors except its advocate. The EAS prevailed over the Capstone by having more connections with other actors, which made the EAS more appealing to the unit chair. By enrolling the unit chair, the champion made her actor-network legitimate and temporarily in domination.

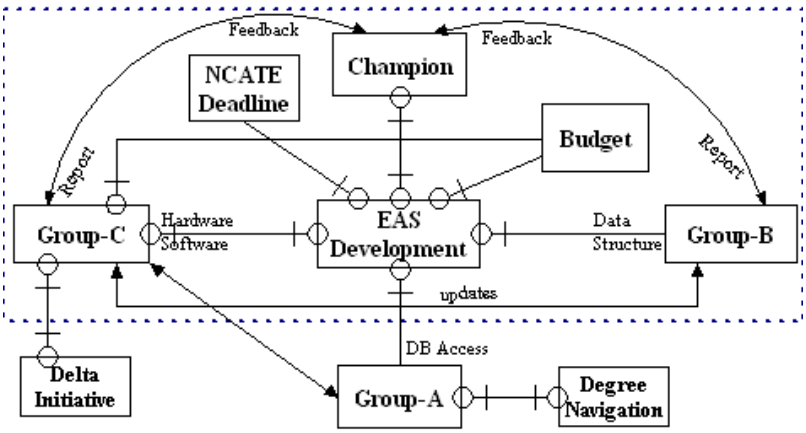
Faculty members emerged from the assessment redesign with a greater understanding of the collective notion of what teacher candidates should know and be able to do at any given point in their programs. They also emerged from the development process with a greater appreciation of variation in how individuals develop and evaluate assessments. Through practice and collaboration, faculty members were working toward greater consensus. These experiences in turn shaped the manner in which they assessed teacher candidates.

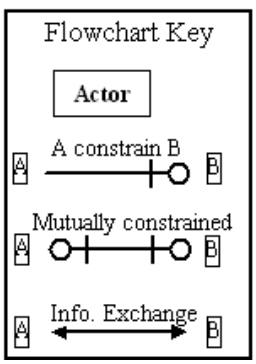
Power Relation and Politics

The translation process was used to show how the power affects the decision making during the IS development. Power is defined as "a capacity of A that influences the behavior of B so that B does things that B would not otherwise do." *Politics* is defined as the attempt to influence "the distribution of advantages and disadvantages within an organization" (Robbins, 1996). The EAS development demonstrated how the wills of different political groups translated and negotiated in the academic environment. Actors for this dimension were depicted in an interaction model (see Figure 7). The champion employed a series of measures to translate the unit's interest and enroll power parties into the actor-network.

Based on Figure 7, the EAS development was constrained by the focal actor (champion), time (NCATE deadline), budget, and resources (groups A, B, and C). To solve the limited budget issues, the champion contacted the Office of Information Technology (OIT) to request hardware and software support for a production system. OIT passed the request to its Web development center (called group A). Group A considered the EAS was too complicated and declined to offer any help because all its staff were occupied with other projects. The champion decided to implement the EAS with the available resources. After inscribing the EAS proposal into a prototype system, the champion decided to enroll the Office of Institutional Research (called group B) into the actor-network for data access. Group B was impressed by the prototype and agreed to work with OIT management (called group C) to look at the possibility of modifying the data dictionary. This time group C paid attention to the EAS endeavor because group B has more power than group C.

Figure 7. Interaction model: Power relation and politics. The actors inside the dotted rectangle represent the final aligned actor-network. The champion controls the EAS development while the EAS shapes the champion's view and strategy to interest and enroll other actors.





OIT: Office of Information Technology
Group-A: OIT Web Development Center
Group-B: Office of Institutional Research and Registrar's Office
Group-C: OIT Top Management

However, group C was not happy with the unit's unilateral conversation with group B, which is reflected in a memorandum sent to group B criticizing the unit's system development and project management. The champion then used the technology lead to ease the tension because the technology lead was well connected with group C. The technology lead presented the possible usage of the EAS for broader audiences beyond teacher education and informed them of the undergoing patent application. Group C changed its position and agreed to provide database support.

Although groups B and C were not fully enrolled into the actor-network, they did not jeopardize the actor-network's stabilization. The champion continued EAS development while keeping group B and group C updated periodically. This diplomatic approach was considered crucial in that either of the two groups could negatively affect the development if they perceived power diversion. The champion continued disseminating the EAS project at different meetings, by demonstrating it indeed worked to facilitate the unit's change process. The aim was to have all related political

groups understand the importance of the EAS and its contribution to the university. The university president even asked group C about the status of the EAS.

Process and Operation

The actor-network inscribed the EAS into various artifacts including an IS, intern handbooks, training manuals, published papers, and state and federal reports. Changes inscribed in the organizational structure became temporarily irreversible because it would be unthinkable or too costly to do so (Callon, 1991; Law & Callon, 1992). The EAS effectively became the medium for inscribing how the unit would operate. Process changes before and after the stabilization of EAS actor-networks were shown in an actor model.

As the unit discovered the potential to achieve better and more with the EAS, the unit changed some processes to take advantage of these new capabilities. The major changes included:

- The Application for Admission to Teacher Certification Program was implemented by the unit at both the undergraduate and graduate levels to reinforce program entrance criteria and assessments.
- The EAS and the program-specific content were developed and further refined with the aim of alignment of curriculum, outcomes, and assessments with the conceptual framework and the various national and state standards.
- Undergraduate and graduate curriculum and advising instruments were revised to align with the five-stage benchmark incorporated in the EAS, and curriculum and advising instruments were developed for two new master's programs.
- Assessment requirements, administration frequency, and timelines were redefined and implemented across programs.
- A syllabus template was developed to help coordinate instructions, expectations, and outcomes across programs.
- Electronic portfolio (EP) assignments were incorporated to facilitate and sustain technology integrated-teaching and learning, and to help demonstrate competencies in meeting the Maryland Teacher Technology Standards.
- A program-wide Clinical Practice Exit Conference was established to evaluate holistically and collaboratively each candidate's performance.
- EP development and assessment became requirements in all intern seminars. EP presentation and review were instituted as part of the clinical practice exit criteria. Unit-wide EP assessments were held to evaluate candidate competencies and to collect feedback on portfolio policy and process.

Users complained about changes when the EAS was in its first pilot semester. One candidate commented "…too much fluctuation within the program." To address this concern, the champion developed a series of customized workshops to familiarize the users with the program changes.

With additional actors enrolled in the actor-network, the EAS was adjusted to accommodate the needs of successive users. The OTE tracked the clinical placement of interns using a spreadsheet program. After joining the actor-network, the OTE's needs became the interest of the actor-network. The EAS was thus changed to accommodate the needs of the OTE and help the champion use the technology to serve the inscribed interests.

Professional Issues

Four different groups used the EAS: teacher candidates, mentors, advisors, and supervisors. *Teaching professionals* are independent and enjoy academic freedom. The actor-network could not successfully persuade professionals to use the EAS by just inscribing the usage into the administration requirements. A process model shows the interactions between professionals and the EAS.

Inscriptions have to be linked to a larger actor-network in order to give them sufficient strengths, which determine the actor-network's stability and domination. Special strategies appropriate to the professional characteristics were employed to enroll the professionals into the actor-network. For example, most of the supervisors were educators with more than 30 years of experience. Most of them were not technology savvy. They speculated that the system was designed only for the administration. First, the champion enrolled two senior faculty members to help present the EAS in various meetings. Second, the champion persuaded program directors to act as delegates in each program to lead the adoption. However, most supervisors printed the forms from the EAS to record the supervising outcomes. This translation result alerted the champion to adopt shorter forms and design a special interface for supervisors, such as Web pages with a larger font size. Some supervisors began using EAS regularly. The stability of the actor-network is only achieved through negotiations between the technology and its social context.

Discussion

The openness for change, leadership support, and active management led to the successful initiation of an actor-network. The dominance of one network over another depended on the way in which a network of actors was able to translate

and inscribe its ideas into convincing social and technical arrangements, and thus impose its desired structure upon other actor-networks. The analysis of translations demonstrated how the political environment shaped technologies, and how it was mutually shaped by technologies. An actor-network should try its best to prevent the power holders from becoming opponents in case they cannot be enrolled in the actor-network. Although the champion initiated the EAS and enrolled the other actors in the network, the *champion* continued to describe the EAS project as a joint effort involving many actors and as a part of the university IT office's strategy. It was important that the political groups did not see the EAS project as something that was out of their control.

The EAS and the unit shaped each other during EAS development. The unit's processes were redefined to accommodate changes inscribed by the actor-network. The EAS was also refined to reflect these process changes. Actors enrolled in the actor-network were mobilized to negotiate a temporary stability between the organization's requirements and the system's capability. The active involvement of the professionals (faculty, mentors, and supervisors), consistent support from the administration (unit, college, and university), and the culture of accepting change (redesign of teacher education and new accreditation standards) were critical to success.

The EAS development evolved as the leadership team and the technology team communicated with each other about the various teacher standards and the functions that would be necessary to support those standards. During this collaborative development, the local practitioners began to share ways that the technology could facilitate the accreditation preparation, while the technology team began to share the content of the process. All actors were contributing to and shaping the actor-networks, which consisted of actions and structures of the unit. The hierarchical decision-making process was replaced by decentralized decision making. The unit established a long-term assessment system development plan as required by the NCATE. Information practice in the unit was no longer an invisible act. The EAS permeated all social practices and became part of daily life.

The analysis showed that the IS and organizational processes were orchestrated to achieve the stability of an actor-network. The actor-network inscribed how the workflow and information should be organized into the IS. The processes inscribed in the IS became *business norms,* which reinforced the legitimacy of the IS and the actor-network. The formation of social structure (process and operation) and technical artifact (EAS) were emergent processes. Neither social nor technical aspects wholly determined the trajectory.

The ANT analysis showed that users affected the IS development, but also the technology influenced the users' way of thinking and acting. ANT provided a vocabulary to describe this complex process (Latour, 1991). The uniqueness of the teaching profession played an important role in the shaping of the EAS and its usage. Professionals would only use the system when they considered that the benefits justify the

costs. This should be given special attention when developing IS for audiences who cannot be coerced into the actor-network, as in the educational context.

Conclusion

This study used ANT to analyze the implementation and consequences of a successful IS implementation in a teacher education program. ANT analysis was applied at four dimensions: organizational culture, power/politics, process/operation, and professional. Translation, inscription, and stabilization of the actor-network were delineated with actor identification, interest translation, and actor-network maintenance. Through translation, the interests of the champion became the interests of a wider network of actors (education community, technicians, and higher management). Through inscription, discourse about education accountability became "frozen" in the EAS, which helped improve the unit's decision-making process and operation. The most important lesson learned from this practical problem situation was that the collaborative modeling and system development process contributed significantly to the shaping of social practices in the unit. This study has demonstrated that IS development is not just about technology development; rather it is also about social development. The lesson learned is applicable to other education programs in similar settings.

This study demonstrates how the actor-networks formed, evolved, and dominated, noting the role played by IS within a teacher education program. The process of change was examined by viewing change as a series of translations and negotiations that engage both human and non-human actors. Few studies in education have exploited the advantages of ANT to study social consequences of IS, but this research provides valuable insights into the processes of translation and inscription by which actor-networks are developed.

The requirements and design of an organizationally integrated IS are never finished or final. The goal is to move an actor-network into an irreversible status, from where it is impossible to go back to a point where alternatives to the IS exist. The ANT analysis leads to identification of potential contending actor-networks, which could be used to adjust translation and inscription strategies to keep the current actor-network in dominance. Future research might examine how to maintain a sustainable actor-network when the actors change dramatically.

References

Atkinson, C.J. (2002, January 7-10). The multidimensional systemic representation of actor networks: Modeling breast cancer treatment decision-making. *Proceedings of the 35th Hawaii International Conference on System Sciences,* Big Island, Hawaii.

Barley, S.R. (1986). Technology as an occasion for structuring: Evidence from observations of CT scanners and the social order of radiology departments. *Administrative Science Quarterly, 31,* 78-108.

Bijker, W.E., & Law, J. (1992). *Shaping technology/building society: Studies in sociotechnical change.* Cambridge, MA/London: MIT Press.

Bloomfield, B.P., & Vurdubakis, T. (1997). Paper traces: Inscribing organisations and information technology. In B.P. Bloomfield, R. Coombs, D. Knights, & D. Littler (Eds.), *Information technology and organisations* (pp. 85-111). Oxford: Oxford University Press.

Callon, M. (1987). Society in the making: The study of technology as a tool for sociological analysis. In W.E. Bijker, T.P. Hughes, & T.J. Pinch (Eds.), *The social construction of technological systems* (pp. 85-103). Cambridge, MA: MIT Press.

Callon, M. (1991). Techno-economic networks and irreversibility. In J. Law (Ed.), *A sociology of monsters: Essays on power, technology and domination* (pp. 132-161). London: Routledge.

Castenell, L.A., Benson, J., deMarrais, K., Butchart, R., & Lewis, J. (2001). From chaos to sanity: Preparing for NCATE 2000 at a comprehensive public institution using an electronic review. *Proceedings of AACTE 2001,* Dallas, TX.

Checkland, P.B. (1981). *Systems thinking, systems practice.* New York: John Wiley & Sons.

de Raadt, V.D. (2001). Multi-modal systems method: The impact of normative factors on community viability. *Systems Research and Behavioral Science, 18*(2), 171-180.

de Vreede, G.J., van Eijck, D.T.T., & Sol, H.G. (1996). Dynamic modeling for reengineering organizations. *Journal of Information Systems and Operational Research, 34*(1), 28-42.

Dooley, K.E. (1999). Towards a holistic model for the diffusion of educational technologies: An integrative review of educational innovative studies. *Educational Technology & Society, 2*(4), 35-45.

Doolin, B., & Lowe, A. (2002). To reveal is to critique: Actor-Network Theory and performativity in critical information systems research. *Journal of Information Technology, 17*(2), 69-78.

Drake, S. (2007). *Creating standards-based integrated curriculum: Aligning curriculum, content, assessment, and instruction.* Thousand Oaks, CA: Corwin Press.

Esnault, L., & Zeiliger, R. (2000). Web learning with NESTOR: The building of a new pedagogical process. In A.K. Aggarwal (Ed.), *Web-based learning: Opportunities and challenges* (pp. 79-102). Hershey, PA: Idea Group.

Folkman, K., & Berge, Z.L. (2002). Learning from home: Implementing technical infrastructure for distributed learning via home-PC within Telenor. *Journal of Educational Computing Research, 26*(1), 51-66.

Giddens, A. (1984). *The constitution of society.* Berkeley, CA: University of California Press.

Grint, K., & Woolgar, S. (1997). *The machine at work: Technology, work, and organization.* Malden, MA: Blackwell.

Hirschheim, R.A., & Klein, H.K. (1989). Four paradigms of information systems development. *Communications of the ACM, 32*(10), 1199-1216.

Klein, H.K., & Myers, M.D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly, 23*(1), 67-93.

Kling, R. (1987). Defining the boundaries of computing across complex organizations. In R.J. Boland & R. Hirschheim (Eds.), *Critical issues in information systems research* (pp. 307-362). New York: John Wiley & Sons.

Kling, R., Kim, G., & King, A. (2003). A bit more to IT: Scholarly communication forums as socio-technical interaction networks. *Journal of the American Society for Information Science and Technology, 54*(1), 47-67.

Larsen, K.R.T. (2003). A taxonomy of antecedents of information systems success: Variable analysis studies. *Journal of Management Information Systems, 20*(2), 169-246.

Latour, B. (1991). Technology is society made durable. In J. Law (Ed.), *A sociology of monsters: Essays on power, technology and domination* (pp. 103-131). New York: Routledge.

Law, J., & Callon, M. (1988). Engineering and sociology in a military aircraft project: A network analysis of technological change. *Social Problems, 35*(3), 284-297.

Law, J., & Callon, M. (1992). The life and death of an artifact: A network analysis of technical change. In W.E. Bijker & J. Law (Eds.), *Shaping technology/building society: Studies in sociotechnical change* (pp. 21-52). Cambridge, MA: MIT Press.

Lewis, T., Marginson, S., & Snyder, I. (2005). The network university? Technology, culture and organisational complexity in contemporary higher education. *Higher Education Quarterly, 59*(1), 56-75.

Linn, R.L. (2000). Assessments and accountability. *Educational Researcher, 23*(9), 4-16.

Linstone, H.A. (1999). *Decision making for technology executives: Using multiple perspectives to improve performance.* Norwood, MA: Artech.

Morgan, W., & Ryan, M. (2003). Rendering an account: An open-state archive in postgraduate supervision. *Higher Education Research and Development, 22*(1), 77–90.

Neyland, D. (2006) Dismissed content and discontent: An analysis of the strategic aspects of Actor-Network Theory. *Science, Technology & Human Values, 31*(1), 29-51.

Orlikowski, W.J. (1991). Integrated information environment or matrix of control? The contradictory implications of information technology. *Accounting, Management, and Information Technologies, 1*(1), 9-42.

Orlikowski, W.J. (1992). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science, 3*(3), 398-427.

Orlikowski, W.J., & Iacono, C.S. (2001). Desperately seeking the 'IT' in IT research—a call to theorizing the IT artifact. *Information Systems Journal, 12*(2), 121-134.

Pickering, A. (1995). *The mangle of practice: Time, agency and science.* Chicago: University of Chicago Press.

Robbins, S.P. (1996). *Organizational behavior: Concepts, controversies, applications.* Englewood Cliffs, NJ: Prentice-Hall.

Scacchi, W. (2004). Socio-technical design. In W.S. Bainbrigde (Ed.), *The encyclopedia of human-computer interaction.* Berkshire.

Steinbruner, J.D. (1974). *The cybernetic theory of decision.* Princeton, NJ: Princeton University Press.

Wilkerson, J.R., & Lang, W.S. (2007). *Assessing teacher competency: Five standards-based steps to valid measurement using the CAATS model.* Thousand Oaks, CA: Corwin.

Wise, A.E. (2001). *Performance-based accreditation: Reform in action.* Retrieved April 28, 2005, from http://www.ncate.org/documents/QualityTeaching/qt-spring2000.pdf

Zhu, Z. (2000). WSR: A systems approach for information systems development. *Systems Research and Behavioral Science, 17*(2), 183-203.