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Towards Anticipating IS Consequences: An Anatomy of Sociotechnical Interaction Networks (STINs)

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Abstract

In this paper we examine questions of how the unintended impacts of information and communications technology can be examined in order to anticipate and safeguard against negative consequences. Using the domain of the eGovernment impacts on marginalized members of the community, we examine the theoretical basis of the sociotechnical interaction network (STIN) approach and its applicability to identifying and ameliorating negative impacts of ICT-based systems. We illustrate the STIN modelling approach with reference to a case study of an integrated eGovernment system and based on our evaluation of the approach, make recommendations regarding future developments with respect to the STIN framework.

Keywords:

Sociotechnical Interaction Networks (STIN), eGovernment, social impact,

INTRODUCTION

A major paradox facing information systems (IS) research and practice relates to the impacts of implemented information and communication systems (ICTs): as we improve our capabilities for designing and implementing ICTs, reports of negative, unintended impacts of their use are growing. There has long been a stream of IS research that has reported on the appropriations of technology at the individual level that lead to unintended impacts of the technology. At an organisational level there have been observations of drift of large-scale infrastructures leading to new and unintended structures and consequent new and unintended impacts (Ciborra, 2000). Although some of these unforeseen impacts may be positive, others will be negative. De Sanctis and Poole (1994) discuss 'unfaithful' appropriations and their possible negative and unintended impacts on both individual usage and organisational outcomes. However, there has been little work on trying to anticipate unintended impacts of ICTs. This is a neglected topic that poses significant theoretical and methodological issues.

In this paper, we examine an approach to anticipating the consequences of ICTs which falls into the fourth of Markus and Robey's (2004) classes of explanations for unintended consequences of ICT use – explaining unintended consequences in terms of the complex interactions between ICTs and social systems. Our approach is based on the Sociotechnical Interaction Network (STIN) modelling framework which was originally developed by the late Rob Kling and his colleagues (Kling et al., 2003). The STIN approach was put forward as "*an important advance in socio-technical analysis, and one that can serve as a basis for more refined and complete subsequent theorizing.*" (Kling et al., 2003:67). Our aim was to take this existing analytical framework that has mainly been applied to the analysis of e-forums and other web-based interaction technologies, and use it in a different domain, addressing different research objectives (namely ICT consequences). We were however, mindful of the dangers inherent in adopting and adapting theoretical constructs from other domains in a dilettante fashion. We therefore examine in depth the theoretical basis of the STIN approach prior to making further recommendations regarding its utility in anticipating unintended consequences.

Our context for investigating these issues is eGovernment and unintended impacts upon people at the margins of society. In this domain, it is important not just to anticipate likely unintended impacts of ICTs but also to build in some safeguards through policy and procedures or even within the information system itself. Thus, the question studied in this paper is: "How can the STIN approach assist in studying and anticipating unintended impacts of eGovernment systems?"

While not a theory in itself, the STIN approach draws on several theoretical constructs from the social constructivist paradigm. We first review the theoretical underpinnings of STIN models in order to identify how the underlying constructs can be applicable. We next examine the appropriateness and suitability of adapting the STIN modelling approach and the underlying theory for our research task through an evaluation of Truex et al.'s (2006) recommendations for adapting theory in information systems research.

Having considered the theoretical foundations of the STIN approach, we refer to an application of the STIN model in understanding the complex interactions between ICT and public sector licensing service delivery to a marginalised community in society. Our analysis demonstrates that while the STIN approach is a useful analytical tool for our task, there are some practical limitations that need to be addressed in order to enable the anticipation of unintended consequences. In light of our findings the final section makes some recommendations as to how the STIN approach might be further adapted to address the problems of unintended impacts of eGovernment systems.

UNINTENDED CONSEQUENCES OF ICTs

The IS/IT literature is littered with accounts of ICT implementations resulting in unexpected and unplanned consequences. Markus and Robey (2004) note that these unexpected results can be positive, negative, or both. They also call for the development of good theory about ICT's unintended consequences as a way of ameliorating the impacts of negative consequences in order to fully exploit positive benefits. Their review identifies classes of theories for explaining unintended consequences of ICT use including explanations in terms of ICT design; explanations in terms of user appropriations; and explanations in terms of complex socio-technical interactions. Our research in the domain of eGovernment impacts uses interactions between the technical and wider social contexts as its focus.

In addition to pursuing Markus and Robey's call for theory for understanding ICT's unintended consequences we are also investigating ways of making this research relevant to practice which appears to frequently ignore the likelihood of unintended consequences. For example, in the eGovernment domain, benefits are often presented in terms of improved service to citizens and providing public value. Demonstrating and measuring how the community benefits - and is affected by - government providing online services is however not a simple task. Typically a business case for eGovernment initiatives is used to assess both the financial benefits that the initiative will generate as well as providing an assessment of proposed social benefits. The approach developed for the Australian Government for example is based on the notion of "demand and value assessments" in which eGovernment business cases identify cost and benefit streams for various stakeholders (King et al. 2004). Using this approach the value of eGovernment initiatives is measured in terms of return on investment. Such an approach promotes sound project management principles and provides the basis for justifying the business case for eGovernment services, relating prospective costs and benefits to different stakeholder groups and identifying project risks.

This conventional approach to evaluating the impact of ICTs on the delivery of government services views the impact of technologies on society as following an inherent logic leading to particular, predictable patterns of use. However, given the common reports of unexpected outcomes (both positive and negative), reliance on predictable outcomes is perhaps short-sighted. The unintended impacts of implementing ICTs, the outcomes of their built-in processes and ways of operating, their potential for linking and integrating data from peripheral systems and agencies and the emergent consequences of melding new policy and legislative initiatives with integrated infrastructures appears to be unexamined, unseen and unthought-of. The process through which systems come-to-be, the possibilities, and decisions made are not recorded and so is largely inaccessible once the system is implemented.

An alternative approach of examining the role of ICTs in the delivery of public sector services is to turn to the tradition of "social shaping" approaches (MacKenzie and Wajcman 1987). In this vein, Dutton (2005) for example, redefines traditional notions of access to technology by viewing it as an unpredictable outcome of the choices made by people and institutions about the design and use (or non-use) of the technology. It is the multitude of interactions between actors that determines the ultimate social, economic, business, educational and other outcomes tied to ICT. Similarly, Danzinger et al. (2002) note that the impacts of ICTs encompass a broad range of processes in which individuals and organisations in various roles are constantly interacting and re-organizing and "these processes of structuration might be altered or shaped by uses of ICT in ways that are often subtle, complex, gradual or delayed, and that are difficult to measure with precision" (Danzinger et al. 2002:5).

SOCIOTECHNICAL INTERACTION NETWORKS (STINS)

Our preliminary analysis of an eGovernment impact case study indicated that our investigation should examine the ICT not in isolation but as a part of a complex interrelated web, ensemble or network of influences. Orlikowski and Iacono (2001) suggest that the ensemble view may examine how the technology *came to be*

(illustrated by the Social Construction of Technology and Actor-Network Theory) or *how it comes to be used* (as seen in the web model of Kling and Scacchi 1982) that describes an ensemble of "*equipment, techniques, applications, and people that define a social context*" as well as the infrastructure, social relations, policies and processes around technology in use). Viewing ICTs as part of an ensemble transcends the view of technology as a tool that can provide defined benefits to governments and acknowledges the emergent outcomes of technology use (Markus and Robey 1988; Carroll 2004).This approach may encourage public administrations to seek to analyse a range of possible outcomes that may emerge from eGovernment initiatives.

In order to examine the impact of ICTs embedded within the service delivery ensemble, we selected Kling et al.'s recommended heuristics for developing STIN models. The authors define a STIN as "*a network that includes people (including organizations), equipment, data, diverse resources …, documents and messages, legal arrangements and enforcement mechanisms, and resource flows*." The relationships between each of these elements of a STIN may be social, economic and political. The focus of Kling et al.'s paper was e-forums but they indicated there were broader applications. We believed that our research objective of understanding the impacts of eGovernment systems could benefit from the application of STIN modelling principles which are embodied in the eight "heuristics" to guide modelling activity provided by Kling et al. (2003). These heuristics are listed in figure 1 and their underlying theory is discussed below.

STINS – UNDERLYING THEORY AND APPLICATION

The development of the socio-technical interaction (STIN) concept (Kling et al. 2003) has been described as one of five "big ideas" contributed by Rob Kling to contemporary information systems studies (Horton et al. 2005). The STIN concept is the culmination of many years of research and study of computerization in organizations and society, having its origins in the seminal "web models" first put forward by Kling and Scacchi (1982) which remain a touchstone for IS researchers today (Orlikowski and Iacono 2001). Although STIN models are recognised as a major contribution by Kling, to date the approach has not been widely applied and even then, these applications have been largely confined to Kling's circle of students and colleagues (Meyer 2006). Meyer (2006) provides a review of the underpinnings of STIN and its limited applications noting that "STIN does not reach the level of theory, nor is it a proper methodology". He suggests that it should be seen as an "analytic strategy" providing "a goal-oriented way of viewing the world" in guiding research and analysis. In order to understand how the STIN approach might contribute understanding unanticipated consequences of ICTs, we examine the underlying concepts that contribute to STIN together with how they are embodied within Kling et al.'s heuristics. This analysis is summarised in Table 1.

Although the STIN approach falls short of actually being a theory, it is laden with concepts borrowed from several other theoretical perspectives. In particular, STINs borrow heavily from concepts related to Actor-Network Theory (ANT) as seen in the work of Latour 1987 and Callon 1986 as well as being in the tradition of the Social Construction of Technology (SCOT) approach which is associated with the work of Bijker, Pinch and others (Bijker, Hughes and Pinch 1987). It is also possible to see within the STIN approach the an amalgam of ideas that constituted the thinking behind Kling's own 'web models' (Kling and Scacchi 1982). In the key publication in which Kling et al. (2003) describe STIN, reference is also made to the 'Ecology of Games' (EoG) model which has its roots in the study of community governance (Long 1958) but notably has been applied to studies of telecommunications policy (Dutton 1992) and access to telecommunications infrastructure (Dutton 1995).

Even though description of how theory contributes to the STIN modelling is rather scant, it is possible to identify how the concepts adopted from ANT, SCOT and the Ecology of Games model contribute to the heuristics outlined by Kling et al. (2003). Meyer's (2006) analysis of STIN models shows how concepts from SCOT and ANT underpin the underlying assumptions on which STIN modelling is based. Meyer (2006) highlights that in line with ANT, actors (or as Kling prefers "participants") may be technical or social but notes that Kling is "more conservative in attributing action to non-human agents" (Kling et al. 2003:56-57). An important distinction from the SCOT and ANT perspective is that STIN draws on the sensitizing concepts of the EoG model to understand the multitude of overlapping and often conflicting relationships between actors to provide an analytical device which enables the modeller to look beyond the sociotechnical system under study. Furthermore whereas ANT and SCOT rely on historical analysis, the more pragmatic aim of STIN models is to provide an analytical framework which enables some *normative predictions* of the future trajectory of the system under study.

The heuristics of STIN modelling described in Kling et al. 2003 are illustrative of the approach to analysing e-forums. While the STIN heuristics are not designed as a step-by-step process for modelling the network, we have classified them into three broad modelling activities; 1. Stakeholder/actor Analysis; 2. Network Relationship Analysis; and 3. Network Trajectory Analysis. Classifying the STIN modeling activities in this way allows an examination of how the underlying theoretical concepts that have been drawn from various social constructivist frameworks are used within the STIN approach.

Table 1: Concepts contributing to the STIN Approach

Modelling Activity / STIN Heuristic	Contributing Theoretical Concepts			
	Actor-Network Theory	SCOT	Ecology of Games	Web Models / other Kling
Stakeholder / Actor Analysis 1. Identify system interactors 2. Identify core interactor groups 3. Identify incentive structures	Heterogeneous actants Problematization	Relevant social groups Technological frames Interpretive flexibility	"Ecology " implies an interrelated set of actors with different players in a territory possibly involved in a variety of games	Social actors are not primarily users of ICTs
Network Relationship Analysis 4. Identify excluded actors and undesired interactions 5. Identify existing communication forums 6. Identify resource flows	Interessement	Alternative solutions	Plays made in one game may affect the play of others	Resource dependency (direct relationships) Account taking (indirect relationships) Affiliations
Network Trajectory Analysis 7. Identify system architectural choice points 8. Map architectural choice points to sociotechnical characteristics	Moments of translation Global and local network dynamics	Design flexibility		Standard Model

Stakeholder/Actor Analysis

The first three heuristics; 1. identify a relevant population of system interactors; 2. identify core interactor groups; and 3. identify incentives; are all directed toward setting the stage for analysis of the system under study. In these steps a stakeholder analysis is performed and the boundary of the sociotechnical networks is defined. To understand the perspective that STIN models take when identifying interactors and interactor groups, the *social actor* concept that Kling developed in conjunction with Roberta Lamb (Lamb and Kling 2003) can be seen to have influence. Social actors are not primarily users of information technology and by viewing network interactors in this way, the focus is shifted away from the traditional notion of *user*.

An ANT analysis implies that key actors are "followed" in order to trace inscriptions and translations. For a STIN analysis the aim is to identify the ecology of interactors and their interests prior to analysis. While the identification of interactors will include heterogeneous actors, from the analytical approach of the Ecology of Games (EoG), it is possible to ascribe interests (incentives) to interactors and the arenas or games with which they are associated. Kling et al.'s concern here is in defining the "business model" that sustains interest in the STIN over time. There is a need to ask the fundamental motivation for interactors' participation. How the ecology of games framework deals with interests (incentives) has important for this aspect of STIN modelling. EoG notes that the various actors are playing individual games in the ecology and therefore there is not necessarily any intent to change the trajectory of the interests of others. They (others) are possibly "playing a different game" within the ecology.

Network Relationship Analysis

The STIN heuristics that contribute to analysing the relationships between actors are: 4. identify excluded actors and undesired interactions; 5. identify existing communication forums; and 6. identify resource flows. Here, the identification of excluded actors and unwanted interactions can be likened to examining those actors who are sidelined through the process of system construction – ie during the *interessement* moment of translation (Callon 1986). Using ANT, during this phase, the key actors try to isolate the actors they wish to enroll from others who may have alternative solutions to the problem. The key actors are trying to build alliances and destroy competing associations. A STIN analysis asks the modeler to identify those who have been isolated – "existing in the white space in network diagrams" (Meyer 2006:42). The identification of resource flows refers to

understanding the direct and indirect influence of interactions in the network. Kling et al. (2003:48) mention that these relationships may be social, economic or political interactions but also make reference to two types of relationships. Resource dependency (links based on access to funding, prestige, trust or legitimated knowledge) is a key aspect of web models (Kling 1987). Account taking dependencies (links based on imitation or social benchmarking) on the other hand is more indirect and Kling et al. acknowledge that this type of relationship is influenced by neo-institutional analysis.

Network Trajectory Analysis

STIN heuristics 7 & 8 (Identify architectural choice points and map to ST characteristics) are used to guide future changes in the trajectory of the STIN development. This is a critical point of departure from the ANT and SCOT approaches which take a historical perspective of system construction. A SCOT analysis would only go as far as identifying various alternative solutions prior to the current network arrangement. Similarly, the focus of ANT is on the process by which the current network arrangement came to be. A STIN analysis on the other hand goes further and aims to enable STIN participants to shape further construction. This is done, by and large, by comparing the STIN model to a "standard model" which can then be "disassembled" (Meyer 2006).

ADAPTING THEORY FOR STIN ANALYSIS

In our use of the STIN approach we were mindful of the warnings of Truex et al. (2006) about the care needed when applying and adapting theories from outside the IS discipline to our research. There is a broad range of theoretical lenses available from within the IS discipline: a list of IS theories "widely used in IS research" lists more than fifty theories (http://www.istheory.yorku.ca/). An IS researcher seeking to select a theoretical lens that is well-suited to a particular research problem, and appropriate for their personal theoretical foundations, faces a difficult task in choosing wisely. It appears that the four recommendations for adapting theory proposed by Truex et al. have value for this selection process generally rather than only when candidate theories are derived from outside the IS discipline. Accordingly, their four recommendations for adapting theory are applied to STIN:

The fit between the theory and the phenomenon of interest. Our initial research was concerned with investigating the impacts of a new licensing system on a marginalised indigenous community. Our initial examination of the topic indicated that it was an ill-structured problem with no clear causal relationships. Exploring the socio-technical networks involved in delivering licensing services required a theory that was based upon, or sympathetic to, a systems viewpoint. The heuristics for developing STIN models, with their focus on identifying relationships among a relevant population of system interactors, fitted well with the problem characteristics. One weakness is the lack of definition of the contents of each step; there was some imprecision about what actually was involved in some of the steps; for example, Kling et al.'s description of Step 4 'Identify excluded actors and undesirable interactions' includes discussion of undesirable interactions but no mention of excluded actors.

The theory's historical context. STIN is an incomplete expression of twenty years of socio-technical work by Rob Kling and associates. It is built upon concepts and assumptions from other streams of thinking including the Social Construction of Technology and ANT as discussed above. The importance of context, the need for equal consideration of the social and the technical and a rejection of technology determinism are emphasised. Thus, these theories are particularly suited to complex social or organisational situations where context, emergence and human agency are crucial.

How the theory impacts the choice of method. STIN appears to be method-agnostic in that no specific recommendations are made about suitable methods. Implicit, however, in any discussion of the importance of contextual and social influences is the need for intensive research, where these contextual and social influences can be noted (through observation or post hoc recollections).

The theorizing process' contribution to cumulative theory, including the relationship with preceding and subsequent theporetical development. This is one of the rare applications of STIN by researchers outside Kling's immediate circle. In addition, through reflection on the application of these ideas, theories and techniques, it adds to the broader pool of existing socio-technical research rather than just that produced by Kling's group.

One risk of adapting theory (Truex et al. 2006) is "*the temptation to adapt and use the bits of a theory that seem applicable to the task at hand without having understood and considered the limits and problems that may be associated with that theory.*" While this is certainly a concern for STIN modelling given the variety of underlying concepts, all of the theoretical concepts that are drawn upon for constructing STIN models are ontologically consistent in that they are all based in social constructivism.

ILLUSTRATING STIN - INTEGRATED EGOVERNMENT SYSTEM IMPACT

To illustrate our application of a STIN approach to understanding impacts of of eGovernment systems we refer to a case study of the Indigenous Licensing Project (ILP) that was managed by the Department for Planning and Infrastructure (DPI) – an agency of the State Government of Western Australia. The details of this study and its findings are reported elsewhere (Letch and Carroll 2008) but for the purpose of illustrating our application of STIN we provide a brief outline of the case details below. The ILP project aimed to "*identify and document the barriers to service delivery in Indigenous communities*" in order to provide "*improved access to licensing services for Indigenous people, particularly those living in remote communities*" The project focused on one marginalised community in a very remote part of WA. Given that the ILP has been specifically initiated to address a perceived mismatch between DPI's licensing system and the needs of remote Indigenous Australians, we used a STIN approach to understand how the socio-technical network of licensing to remote indigenous communities had been constructed as well as exploring the role played by the ICTs that are embedded in the delivery of the licensing service.

The Integrated Licensing System

In WA, DPI is responsible for policy and legislation regulating driver licensing. Central to DPI's licensing operations is an integrated database that provides a single view of data about the licensing of drivers and vehicles. This recently introduced licensing database (called TRELIS) was developed over ten years and incorporates thousands of complex business rules governing driver and vehicle licensing. While TRELIS acts as the fundamental ICT infrastructure for licensing, a recent policy has been implemented to reduce high levels of road trauma among novice drivers. This policy, the Graduated Driver Training and Licensing policy (GDT&L), covers issuing of learners' permits, driver testing and issuing and renewing licenses. It is implemented via TRELIS and supplemented by two additional ICT systems: a computer-based road rules test and a computer-based hazard perception test (a packaged application containing many scenarios featuring likely driving hazards).

Although driver and vehicle licensing is often depicted in popular culture as a mundane bureaucratic activity, it is actually a highly complex system involving multiple agencies and stakeholders (Ciborra 2005). As well as driver licenses acting as a warrant for many day-to-day activities (eg banking) the activities involved in gaining and holding driver and vehicle licenses touches the legal system, crime enforcement, road safety, the motor vehicle and insurance industries. The complexities of driver licensing and the difficulty in designing systems that meet the needs of all citizens was highlighted in our analysis of the ILP where each phase of the new integrated licensing system posed particular challenges for indigenous people living in remote communities. For instance, even the seemingly simple task of proving one's identity to create a learner record on TRELIS is a problem for many members of indigenous communities because they may not have any birth records or other existing forms of identification.

The Indigenous Licensing Project (ILP) was set up to examine the barriers to licensing for members of the Ngaan community. The living conditions and services for the Ngaan community are completely foreign to those encountered by the majority of the citizens of WA. Most roads around the community are gravel. People travel extensively through the bush but a lack of roadworthy cars is a common road safety concern. People often travel in open load spaces leading to multiple fatalities in car crashes (which are common). When community members travel on tracks or roads they risk detection (unlicensed drivers, unroadworthy vehicles) by the police. Imprisonment rates are high for people from Ngaan due to unpaid fines and road offences. One interviewee noted that "there is no culture of having a driver's license". He estimated that about 16 of the 1600 members of the Ngaan community currently have a license.

STIN Analysis of the Indigenous Licensing Project

It was within the case study context of Ngaan and the ILP that we referred to the STIN modelling heuristics. When applying the heuristics related to identifying the core interactors and their interests, it immediately became clear that the ILP project could not be viewed just as a network of influences at the one level but as a series of interacting networks that were more engaged with, or distant to, Ngaan and having more direct (through day-to-day interactions with the licensing system and its customers) or indirect (through the ability to create policy/provide resources/determine strategic direction) power. Thus we needed to extend the work of Kling et al. and differentiate the interactors in terms of their levels of engagement and influence. This is pictured in Figure 2 with networks having greater engagement/direct power shown at the bottom, rising to lesser engagement/more indirect power at the top of the figure.

The STIN modelling heuristics next recommend the identification of incentives which is likened to defining the underlying business model and asking questions about how the system will add value to the core interactors on an ongoing basis. Applying these questions to the Ngaan situation highlights the contradiction between the process of gaining a license (that is educational and supportive of the learner) and the difficulties faced by

remote indigenous people in retaining their licenses (as the probationary period is characterised by punitive measures and is embedded with values that are meaningless to them).

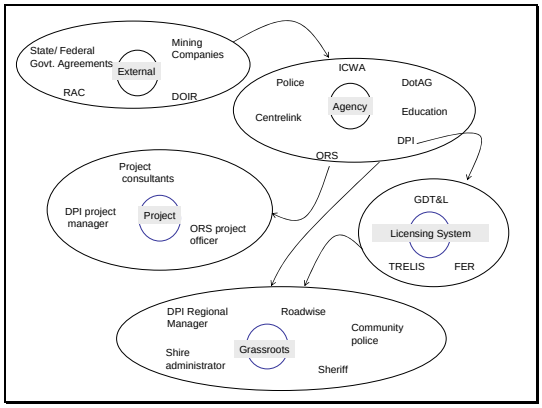

Figure 1: Ngaan Community Licensing STIN

Analysis of STIN relationships suggest identifying excluded actors and undesirable interactions. Figure 1 shows that even though the STIN is concerned with licensing services for the Ngaan Community, the community members themselves are not present in the model. There are many public servants and other interested parties but no indigenous people from Ngaan. Community members interact with the system via intermediaries: the system is applied to them. The underlying technology of the licensing system is invisible to community members – it is subsumed into the infrastructure of the wider system. The information technologies that are embedded in the licensing system infrastructure were designed and implemented without specific consideration of the special requirements of remote indigenous communities. Furthermore, as the licensing system has become integrated with systems beyond DPI's areas of policy responsibility undesirable and unintended consequences have emerged where imprisonment is enforced for unpaid fines for relatively minor offences.

The final heuristic for analysing network relationships related to the identification of resource flows and tracing how the effects of money, power, political interests and special interest groups flow through the network. Although all groups directly involved in working with the Ngaan people have good intentions and a great drive to try to rectify their social, economic and political exclusion. The grassroots groups interact directly with the Ngaan people but have little power to work around or change the system or the policies expressed in the system. Also, the lack of coordination between the various systems interactors is clear. The DPI licensing system is only concerned with granting and renewing licenses. When community members lose their license due to traffic breaches or fines suspension, these penalties are enforced by other interested agencies. TRELIS provides the common point of interaction and documentation whereas co-ordination of strategies and interventions is required: resources need to flow across these groups to achieve such cooperation. Most efforts to alleviate the situation are directed at a single issue, by a single agency, for a short time period.

The activities of STIN modelling that relate to analysing the future trajectory of the system involves first identifying places where choice for the designer exists. It is during this phase that it might be possible to identify both choices and safeguards. Our project examined the licensing system post-hoc and as such it did not extend to recommending further action or reconfiguration of the system. Furthermore, because the technology of the system is "sunk" within the broader licensing service delivery mechanisms, it is only possible to evaluate previous choice points where technology design decisions have been made. The Indigenous Licensing Project itself is however a critical choice point in the (re-)construction of the licensing service. It provides a forum for evaluating and rethinking policy, as well as enabling an evaluation of the impacts of future choices. In reality it is only possible to influence those choices that currently exist. Given that it is unlikely that ICT systems will be re-written or that there will be significant changes to the policies of the GDT&L, it is likely that any changes will be low-level, quick fixes, and not systems-wide, big picture choices.

STIN MODELS AS A BASIS FOR ANTICIPATING AND SAFEGUARDING UNINTENDED IMPACTS

In line with the suggestion that the steps for developing STIN models "should be taken as illustrative, rather than strictly enumerative" (Kling et al. 2003:57), our application of the STIN heuristics to a very different sort of problem than e-forums, aggregated some of these steps and placed more emphasis on understanding actors and their relationships in terms of their interest and influence. We found that for the Ngaan community, the ICT-

based systems embedded within the wider infrastructure of licensing service delivery not only promoted a system that did not meet the special needs of remote communities (because they are inscribed with inflexible and inappropriate rules and procedures), they also compounded existing social inequities and isolation through the integration of the system with the wider eGovernment infrastructure. The STIN analysis in this case proved to be a useful approach for identifying impacts.

Most of the limited applications of STIN models to date have been in flexible and highly malleable formative contexts such as eForums (Kling et al. 2003, Barab et al. 2004) and web information systems (Eschenfelder and Chase, 2002) and have focused on examining the process of social construction for these systems. The system that we studied is more deeply embedded within institutional and organizational infrastructure than previous studies. It is much more difficult to unpick these systems and determine how they have been shaped. However, our research is concerned with the wider formative context and examining the impact of the technologies embedded in the infrastructure and this objective is a strength of the STIN approach. We began our study with a focus on the impact of ICT systems in delivering licensing services to the Ngaan Community. As our STIN analysis proceeded, it became apparent that the particular social challenges faced by the Ngaan Community were enmeshed with the delivery of the GDT&L policy to community members. Tracing how TRELIS and other ICT mechanisms of the GDT&L impacted licensing services in Ngaan shifted the focus of our analysis to groups of actors beyond the immediate delivery of services. The ability to shift analysis from the local to the global is a central feature of ANT (Lea et al., 1995) and this theoretical device assists in tracing the influence of the business rules inscribed into TRELIS via the GDT&L policy. The technology here acts as a constraint on the local adaptations that are necessary in the Ngaan community to enable universal and equitable access to the licensing service.

While STIN models do suggest relationships of resource dependency and account taking, there is no apparent assessment of priorities or representation of any hierarchy of power. In our study we found that there are those who are more closely engaged with the system delivered to the Ngaan Community (grassroots actors). These actors are well aware of the community needs but have very little power to change the system since changes must come from the global network. In a government service delivery context in which long-term bureaucratic procedures can endure for many years or policy may be changed at Ministerial direction, it is important to explicitly recognise which actors have the power to make changes.

Although our application of the STIN approach found it to be a useful analytical device, it still encouraged us to look backward (in line with ANT) rather than forward. It therefore fell short in terms of being able to determine "*ahead of time who the relevant participants will be and attempting to understand the socio-technical networks that these participants are embedded in.*" (Kling et al. 2003:66). As noted above, given that the ICTs are deeply enmeshed within the wider licensing infrastructure, it is likely that any recommended changes arising from the ILP will be low-level, quick fixes rather than systemic changes. Any changes for the licensing system at Ngaan are unlikely to be sustained if there is an absence of representatives from the Ngaan community (Braa et al. 2004): enduring change will require active engagement and leadership by the Ngaan people in devising, trialling, modifying and evaluating (possibly multiple) interventions.

Presently, the STIN approach does not address how to influence future network trajectories or how future changes might be made. Given our broader research task of not only identifying unintended impacts but also safeguarding against them, it would seem that the STIN models produced as a result of following the heuristics, would need to be used as part of a methodology for change. One approach to explore further development of STIN is to examine participatory design principles such as those embedded in the Constructive Technology Assessment (CTA) approach (Rip 1995; Schot 2001)- an approach which is also imbued with the constructs of social constructivism and ANT. The CTA approach calls for "*…technological development to be a broader, interactive process including a variety of societal actors in addition to technical experts*" (Schot 1991:41). While on the surface, this appears to be little different to the decades of accepted wisdom that information systems development requires user participation, in an eGovernment context, the STIN modelling approach identifies much broader "user" constituencies than are addressed during information systems development. This extension of STIN modelling to enhance the predictive capacity of the approach is an area for further research addressing the broader questions related to safeguarding against unintended consequences.

CONCLUSION

The aim in this paper has been to examine the suitability of the STIN approach for investigating questions surrounding the unintended impacts of ICT-based systems, particularly in the context of eGovernment. Our approach has been to firstly examine the contributions of theoretical constructs adopted and adapted within the STIN approach and this indicated that there is a theoretical coherence in using STIN for this problem. Our illustration of STIN analysis applied to the difficulties faced by the Ngaan community in obtaining licensing services demonstrated that STIN modelling has utility in teasing out the unintended and unseen impacts.

However, as an approach to anticipating unintended consequences and developing practical guidelines for the management of ICT developments, the STIN approach falls short.

The goal of the Constructive Technology Assessment (CTA) approach is to develop technologies with desired positive impacts while limiting (or at least managing) negative impacts. Given that CTA is based on theoretical constructs that are also embodied with STIN (eg Callon, 1995), CTA principles may be used to further the applicability of the STIN approach to not only identifying unintended consequences but to also designing measures to safeguard against them.

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