IS security, trust and culture: a theoretical framework for managing IS security in multicultural settings

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Abstract

System security today focuses on the design of safe and secure information systems and their operation. In the analysis of any information system, whether small or large, one observes within it a "set of human activities related to each other so they can be viewed as a whole". If one particularly focuses on security aspects of large information systems, and then considers the many layers of complexity comprising the human activity systems within them, it becomes apparent that one of these layers, or subsystems, is a cultural one. This paper proposes that the perspective gained on the impact of culture in such a system by the application of a systems theory, augmented by perspectives supplied by worldview theory, is helpful in designing appropriate learning, e-commerce or other kinds of distributed environments for multicultural settings.

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Introduction

The terrorist attacks of 11 September 2001 have created a new focus on cultural issues since mainstream information warfare (IW) or security researchers had not fully appreciated that cultural effects (a very determined religious fundamentalism) would drive an individual to use an aircraft for such specific terrorist purposes. Currently IW researchers are considering what other kinds of terrorist activity, particularly cyberterrorism, might be possible, or expected, and examining whether there are methods of predicting such activity.

Complex information system security today focuses on the design of safe and secure information systems and their operation. Various system components are analysed and then steps are taken toward making not only the single components, such as operating systems, databases, communication channels and user interfaces secure, but also in ensuring the security of the interfaces between these components. Risk and requirements analysis techniques also contribute to making systems more secure, and multilevel system security and more advanced cryptographic protection of transactions have already impeded the progress of intruders.

Organisational aspects of information technology (IT) security become important, making it clear that technology alone cannot lead to an adequate solution. A proper analysis of security requirements reveals that the issue of system security has to be dealt with at different levels. One hypothesis is that these levels follow the phases of the software design process; others group security requirements according to the ISO-OSI or IEEE network architecture models. Both approaches do however only cover the ICT architecture and infrastructure of a company. They do not deal with the related human factor or organisational issues.

The question of culture had already become an important issue for researchers and users of distributed computing systems who, before September 2001, were asking questions linking software and hardware design and development and human factors such as culture. These include:

- How can one construct a formal model for the specification of software from a range of

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organisational and national cultural perspectives? If this possible, can one then develop tools to support the required multi-party decision-making? (Finkelstein and Fuks, 1989).

- Does national culture affect the way an individual uses the computer and the interfaces he or she might choose? Which interface elements are more problematic? (Cagiltay, 1999).
- Is there a cultural effect on the cohesiveness of distributed teams working in a technologically mediated manner across national boundaries? (Rathod and Miranda, 1999; Vogel *et al.*, 2001).
- How can we develop and manage cultural differences in virtual software teams? (Dafoulas and Macaulay, 2001).
- How can we develop a guide for the US military to incorporate cross-cultural perspectives within ICT development? Would the use of the concepts of complex socio-technical systems and self-organisation aid in this process (CCRP, 2001).

The growing number of attacks on supposedly secure computer systems, such as that of the White House and Pentagon, were already causing considerable concern to Western governments before 11 September. These kinds of attacks first predominated within e-commerce, and have become even more of a problem as government and the military begin to offer many more of their services online, or rely more heavily on distributed information systems to provide their operating data. Current information about the War on Terrorism in Afghanistan for example suggests that this war stands apart in its dependency on the Internet and other closed networks as tools for military planning – obviously defence against cyberterrorism becomes even more important in this kind of war.

One of the major organisational issues to face is the human factor within IT security. Although media focuses on external attacks, it is recognised that up to 40 percent of IT security related crime arises from malice or error from staff of the organisation (Davey, 2001). Many secure systems rely on pin numbers or passwords. Systems become very vulnerable where employees, either deliberately or inadvertently, disclose such passwords to others. There are many different reasons why an individual might choose to disclose a password (even when he or she had a very good understanding of the sensitive nature of the data within the protected system). This can be seen as an issue of trust.

The aim of this research is to model the relationship between trust (as exemplified in the disclosure of a password to a secure system) and culture. The outcomes will be an understanding of the correlations between self-identified belief system, gender and trust.

Theoretical model

The context here is that current systems engineering (SE), software engineering (SWE), computer science (CS) and information systems (IS) research recognise (Cook and Sproles, 2000; Mitleton-Kelly, 2002) distributed computing systems as complex socio-technical systems, since they can be idealised as open systems that "depend on the technology, the sentiments of the members, and the organisational environment" (Checkland, 1981). Although these systems are organised to focus on a primary task, which might be the support of learning, electronic commerce, or national and international defence, this task and the outcomes (from the system) cannot be separated from the environment and the social factors within which the system is operating.

Much recent research from CS, SWE, SE and IS identifies culture (also expressed synonymously as sense making, viewpoints and world view) as an important variable within those systems. Soft systems methodologies (Checkland, 1981), Kline's complexity hypotheses (Kline, 1995) and theories of complexity drawn from disciplines such as computer simulation, mathematics and physics (Mitleton-Kelly, 2002, p. 1) have provided helpful insight into the conceptualisation, analysis, engineering and development of complex information systems. This involves producing three perspectives (views) of the system being developed (Kline, 1995). These views are:

- *A synoptic view*: an overview with a top-down approach for extracting and synthesising system properties.
- *A piecewise view*: one that identifies and examines the smallest portions of a system that might be relevant in providing information to aid in the solution of any particular problem within the system.
- *A structural view*: one that provides details of how each piece fits together within a particular system as well as providing information on the relationship between local and global effects within the system.

However, while these have provided an overarching theoretical framework at the macro level to begin to explore this issue (Slay, 2001; 2002; Slay and Burke, 2001, Quirchmayr and Slay, 2001), further work is needed to develop an understanding of the role of culture in systems in general, and in the development of secure systems in particular, before this thinking may be extended to deal with its effect on generic characteristics of complex engineered systems such as self-organisation, emergent properties and, more importantly within the context of this project, feedback and control.

It is recognised (Straub *et al.*, 2002) that cross-cultural work in these technological disciplines "remains in its infancy" because of the "lack of unanimity about the underlying meaning and definition of the underlying construct 'culture'". Culture is most commonly defined as a set of shared values, shared understanding or even shared methods of problem solving but some (e.g. Hall, 1976) still use a definition of culture that is all-encompassing (Straub *et al.*, 2002) and abstract in manner and which provides very little help in the identification of cultural properties. These various definitions and understandings of culture have led to a wide range of approaches from those who are dealing with cross-cultural issues in HCI, IS, CS and military command and control (C2) systems. These approaches generally involve identification of a series of values which are shared by every culture (e.g. age-grading, taboos, numerals, tool making (Murdock, 1965)) and then studying individuals within specific communities to understand for example that particular community's taboos, and how this might affect the community's decision-making or learning processes. Straub *et al.* (2002) comment that it is the lack of clear concepts which makes cross-cultural research in the engineering of complex information systems difficult to conduct, and also links the effect of this lack of clarity to our inability to "develop and refine theories" and to explain why there is difficulty in explaining the high degree of variance in current predictive models.

Significant contributions to an understanding of the effect of culture in IS, and more generally in ICT, have been made by Hofstede (1980, 1983, 1991, 1998) whose work in assigning a culture-value by assigning cultural dimensions to a particular group of people is widely referenced (e.g. Dafoulas and Macaulay, 2001; Vogel *et al.*, 2001; Straub *et al.*, 2002; Rathod and Miranda, 1999; Cagiltay, 1999). Hofstede's (1980, 1983, 1991, 1998) work is highly regarded but an examination of his work shows that a major problem with Hofstede's analysis is that it is relatively simplistic in a more modern cross-cultural environment since he identifies only four factors (dimensions) by which one culture is differentiated from another. These are power distance, collectivism v. individualism, femininity v. masculinity and uncertainty avoidance. This is as opposed to Murdock (1965) who found 72 different factors. Hofstede's (1980, 1983, 1991, 1998) methodology involved interviewing large numbers of employees of IBM internationally and questioning them about issues such as their opinion of their supervisor's decision-making style. From this data, he produced cultural indicators (quantifiers) for many nationalities. Another weakness of his methodology is that these values are assigned to a culture and so no allowance can be made, for example, for multiculturalism (i.e. this does not allow for the cultural differences which are displayed and valued by ethnic minorities internationally or for individuals such as Chinese or Greek Australians who may display characteristics of two cultures in their behaviour and decision-making).

Others have derived different value-sets in a similar manner and applied these within organisational and professional cultures (Laurent, 1991; Schein, 1997) but a literature review has not produced a theoretical model that will allow for the identification and

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measurement of culture in the engineering of complex information systems. It is unclear to modern researchers in these fields whether culture is the structural phenomenon that Hofstede proposed, or even whether it has unique generalisable characteristics. It is thus very difficult to investigate, identify, model or measure cultural effects while there is still widespread epistemological debate as to the primary nature of culture.

While there is no apparent agreement within SE, SWE, CS and IS research, several candidate theories exist for the conceptualisation and measurement of culture in the engineering of complex systems. Straub proposes that social identity theory (SIT) (Tajfel, 1978) is a candidate theory for a positivist (scientific) model of the role of culture. This theory presupposes that individuals know whether they belong to a cultural group or not and queries individuals as to the extent to which their cultural values resemble those of others in a particular cultural group. Straub *et al.* (2002) notes that SIT would allow the robust positivist method of "comparison and contrast" and allows variation in measures of social identification within a particular group. (Here one may define positivist methods as those whose research validity may be measured scientifically (Guba and Lincoln, 1985) by generalisation, reliability and objectivity.)

Another candidate theory may be borrowed from science education. Cobern's (1991, 1995, 1998; Cobern and Loving, 1998) research appears to stand alone within science education and gives a clear understanding of the role of culture in learning scientific principles and even in developing the ability to apply "scientific" reasoning and thus providing a positivist model of the role of culture. Cobern's strength is that he introduces the Kearney (1984) anthropological model of world view so as to provide an anthropological framework around which to structure an understanding of the role of culture in science education. His methodology, however, is similar to Straub's *et al.* (2002) inasmuch as he queries his subjects as to their own understanding of their conceptualisations and thus derives his assertions through a process of deductive scientific reasoning. Other candidate theories include Hong *et al.*'s dynamic constructivist analysis (DCA) (2000) and Straub *et al.*'s (2001) cultural influence modelling (CIM).

Each candidate theory mentioned above, SIT, CIM, DCA and Cobern's world view analysis, has a well-defined research methodology associated. These vary in small details from one theory to another but the outcome of the theoretical research of Straub *et al.* (2001), Cobern (1995) and Hong *et al.* (2000) is a series of validated survey instruments which have already been used productively in other scientific domains to question groups of students or managers. These have already been used to identify links between culture and IT transfer, culture and the learning of scientific principles and culture and understanding respectively.

I am choosing to follow Cobern's methodology (1991, 1995, 1998), with his support, and to apply it within the area of holistic approaches to IS security, examining the relationship between IS students and the effect of their trust in the other, as represented by a parent, sibling, close friend, or partner, on the disclosure of passwords to secure systems. Cobern adapted a methodology that is already well established within social science and recently applied it to cross-cultural research in science education in the USA. This paper extends the methodology into the modelling of human factors within IS security as a precursor to fieldwork which will implement the methodology.

Applying Kline's analysis of complex systems

Kline's hypothesis (Kline, 1995), is that at least three views are needed for a reasonably good understanding of hierarchically structured systems with interfaces of mutual constraint: synoptic, piecewise and structural.

Structural view

Arguably, the most common type of architecture view is the structural view in which a system is depicted as a set of inter-related elements. Examples include:

- blue-prints used by the architects of buildings and engineers in general; and

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- organisation charts used to depict the authority/responsibility structures in institutions.

A structural view of a typical IS would therefore show the way all the elements within the system fitted together.

Piecewise view

Another common view is the piecewise view that depicts the smallest relevant parts of a system for a particular problem. Examples include:

- detailed wiring diagrams produced by electronic and electrical engineers that show the smallest components of the devices with which they are concerned and the way that they are inter-connected; and
- musical scores used by composers to depict the notes to be played by the instruments in orchestras.

A piecewise view of an IS would therefore include all the individual people involved in its creation, use and maintenance.

Synoptic view

A less common type of architecture view is the synoptic view. Synoptic views treat systems as atomic entities or wholes. They selectively emphasise characteristics of the system that are deemed to be salient in a given context and suppress information that is not pertinent in these respects. Examples include:

- the synoptic weather charts used in television and newspaper weather reports; and
- topographical, political, climatic, demographic etc. maps.

Integrating the three views

This is best illustrated by considering a lifelike to scenario introduced previously. Let us assume a large Australian company is developing a joint venture with a Chinese company and is looking for interoperability with its partner as they seek to extend their distributed networking via the Internet. It has a major need to protect the integrity of its system and will need to consider how its IS security policy will be affected by this development

When we use Kline's (1995) analysis we can readily obtain a structural view of both the Australian and Chinese information systems. We can also develop a piecewise view of all the players, the professional staff, administrative staff and technicians who will be working together, to conceptualise, design, develop, administer and program the system. Worldview theory gives an opportunity to begin to identify where cultural factors begin to come into play and thus enable the development of a cultural synopsis of the system by the use of the general categories identified by Kearney (1984):

- The other.
- Classification.
- Causality.
- Relationship.
- Self.
- Time and space.

When we begin to investigate the concept of trust and its effect on IS security and then consider relationship to the other, within this context, then factors which need to be taken into consideration are:

- *Attitude to authority*: does one culture behave in a more authoritarian way to the other (can an older person "force" respect or trust from a younger one)?
- *Attitude to age and youth*: does one culture value the contribution of older people with more respect than the other?
- *Value of loyalty and previous working relationship*: does one culture place higher regard on personal loyalty than the other?
- *Formality in relationship*: will one culture value a more formal relationship than the other?
- *Gender differences*: is there a difference in the role women play – are females trusted in different ways in this culture?

Each of these factors might increase the risk of breaches IS security when working cross-culturally

We can look then at causality and ask:

Does each culture understand causality in the same way: are there strong religious or philosophical beliefs that will cause individuals to explain issues in "non scientific" ways? Is superstition an issue? Does each culture espouse a Western scientific explanation for natural phenomena?

Conclusion and further work

The development of these three views of any given human activity system provides valuable

advice to an enterprise seeking to examine its own cultural makeup and the potential impact of this on IS security, particularly while working cross-culturally both inside and outside of Australia. When considering the possibilities of merging institutional cultures or international expansion (and thus forming a system of systems), it is important to recognise that each institution will bring a different group worldview (whether a Western scientific one or a non-Western one), and individual perspectives which will produce a lack of uniformity within the system. This preliminary analysis shows that enterprises could be guided in their internal, external and global expansion and maintenance of there security by the application of Kline's (1995) type of analysis, supported by insights drawn from anthropology as encapsulated in worldview theory.

Further work will be carried out structured interview techniques and an anonymous survey to examine the relationship between belief system, gender and degree of trust in a significant other.

Data required for the proposed research will be collected from students studying in the University of South Australia and Flinders University of South Australia. In all, 200 students each from Asian (Group 1) and Western (Group 2) backgrounds will be selected using a random sampling technique. The student registers will be used to randomly choose the respondents. Equal number of males and females will be selected for both the groups. Initially, Group 1 samples will be selected and their background characteristics such as age and year of study in the university will be used as selection criteria for Group 2. The respondents randomly selected for the proposed research will be contacted and explained the nature of this research. Those who are willing to participate in the research will be interviewed using an interview schedule. The research team will prepare an interview schedule for the study purpose.

It will specifically examine individuals who have been brought up within a belief system that they self-identify as Confucian (generally Asians of Chinese racial origin from China and any other part of the Chinese Diaspora) and others who self-identify as Western (non – Confucian). It will examine the probability of their disclosure of secret passwords to a parent of same and other sex, same and other gender sibling, close friend or partner.

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